Inventory of Water Quality on Santa Rosa Island, Channel Islands National Park

REPORT PREPARED BY
CECE SELLGREN, RANGE CONSERVATIONIST

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EXECUTIVE SUMMARY

An inventory of water quality was conducted on Santa Rosa Island, Channel Islands National Park. The purpose of the inventory was to establish a baseline inventory of chemical, physical, and biological parameters of three streams on Santa Rosa Island and to establish a monitoring protocol for monitoring water quality. The baseline inventory will be used to compare conditions under the current ranch operations with future conditions. The monitoring protocol will join other protocols in the park's inventory and monitoring program.

A total of 26 observations of water quality were taken between October, 1993 and December, 1994. Discharge, water and air temperature, pH, conductivity, salinity, turbidity, and dissolved Oxygen were measured at 12 sites in three drainages. Results indicate that base flows are extremely low, averaging 0.025 cfs to 0.198 cfs. It is estimated that over 99% of flow occurs during rainfall events. Stream temperatures are unusually warm, reflecting the lack of riparian cover.

The water in Quemada Canyon appears to be considerably more saline and have higher conductivity and more total dissolved solids than do the waters of the other two drainages. The waters on Santa Rosa Island consistently had mean total and fecal coliform levels well in excess of the maximum standard (200 MPN/100 ml) set for the island's beneficial use of water contact recreation. Lobo Canyon, Quemada Canyon, and Water Canyon exceeded the maximum standard by 7 times, 16 times, and 17 times respectively out of 19 observations made during the 15-month inventory.

In the spring of 1994 additional monitoring of coliform levels was conducted to ascertain if elevated levels were occurring throughout the drainages in Quemada Canyon and Water Canyon. Six observations of total and fecal coliform were made in April, 1994 in Quemada Canyon and six observations of total and fecal coliform were made in May, 1994 in Water Canyon. The geometric mean of these observations was 4282 MPN/100 ml (total coliform) and 3086 MPN/100 ml (fecal coliform) in Quemada Canyon and 5360 MPN/100 ml (total coliform) and 3794 MPN/100 ml (fecal coliform) in Water Canyon.

Recommendations for the water quality monitoring protocol include:

1. Expanding the number of streams monitored.
2. Reducing the monitoring frequency to once a month.
3. Excluding some sites that lacked sufficient flow.
4. Discontinuing some of the laboratory analysis.
5. Installing an automated sampler to monitor discharge and suspended sediments during storm events.

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I. INTRODUCTION

There are two objectives of the water quality study on Santa Rosa Island. The first is to establish a baseline inventory of physical, chemical, and biological parameters reflecting conditions under the current land use. The second objective is to develop a protocol to monitor water quality. This protocol will join other protocols for the inventory and monitoring program at Channel Islands National Park.

At 54,000 acres, Santa Rosa Island is the second largest island within Channel Islands National Park. Purchased in 1986 from the Vail and Vickers Co, the island supports a traditional cattle ranch and a commercial hunt operation under a special use permit. The island was colonized by Spanish immigrants in the early 19th Century. By 1850 sheep ranching was well under way. By 1890 over 125,000 head of sheep were grazing the island. In 1902 the Vail and Vickers Co. purchased the island and converted its land use to cattle grazing. In the late 1920's elk and deer were introduced which are commercially hunted today. The cattle ranch and commercial hunt operations are guided by a special use permit and will end in 2011.

The island's vegetation is dominated by grasslands which cover two-thirds of the island. Another 22% of the island is covered by shrublands with coastal sage scrub being the most common shrub type. Approximately 7% of the island is bare ground. Less than 1% of the island is covered by woodlands (Clark, *et al*, 1990). There are 10 rare plant species proposed for listing as threatened by the US Fish and Wildlife Service. This includes five species or subspecies which occur only on Santa Rosa Island. There are several species of exotic pest plants.

The ranch operated by the Vail and Vickers Cattle Co. is a stocker operation where calves are brought to the island, usually in the fall, and fattened on the island for approximately 18 months and then taken off the island to a feed lot (Bartolome and Clawson, 1992). The ranch uses a continuous grazing system where cattle spend an entire year or more in one pasture with little pasture rotation of the cattle.

The island is broken up into 10 pastures. Only five of these pastures (totaling approximately 50,000 acres) are used to graze cattle with the continuous grazing system. The other five pastures are holding pastures. Because the pastures are so large (up to 24,000 acres) and water sources so few, the island experiences patchy use by the cattle. In these types of situations, forage resources are underutilized in upland areas while forage near streams is more intensively utilized (Valentine, 1990). The ranch has created very few water developments, forcing the cattle to obtain water from streams. This leads to extensive use of and damage to the riparian areas (Stoddart, *et al*, 1990). Cattle use of streams and riparian areas seems to increase substantially during the hotter summer months. The condition of the streams and associated riparian areas on Santa Rosa Island reflect past and current land uses. Most streams on the island are incised between five and twenty feet and have little if any riparian vegetation on the stream banks.

The arroyo systems common throughout the southwestern United States have most likely developed over thousands of years. This process was likely intensified during the peak sheep-grazing years in the latter part of the 19th Century. Continued cattle grazing has prevented natural recovery of stream morphology and riparian community structure and function. Consequently, many streams are type G or F on the Rosgen scale of channel morphology. Please refer to Figure 1 on Page 3 (Rosgen, 1994). The majority of the streams only support herbaceous riparian vegetation. In many cases vegetation cover is sparse. In most cases there is poor definition of stream banks due to hoof sheer. The net result is streams which are not functioning properly in their role to trap sediments, dissipate flood energy, maintain water temperature, regulate flow, and provide quality habitat for the variety of wildlife species that depends upon riparian corridors (Platts and Raleigh, 1984).

Examination of old stream channels in abandoned flood plains shows many were likely type C channels prior to the onset of channel degradation. Type C channels in central California frequently support riparian communities dominated by willows and other shrubs. Many of the streams on Santa Rosa have remnant shrubs or trees. There are a few sections in Lobo Canyon and Windmill Canyon which are relatively isolated from cattle grazing that have a more shrubby riparian corridor.

In March, 1995 an inter disciplinary team assessed several reaches of streams on Santa Rosa Island for functionality. The team used the methodology in *Process for Assessing Proper Functioning Condition* (USDI, 1993).

Only two reaches within Lobo Canyon were determined to be in *proper functioning condition*. Two reaches, one in Windmill Canyon and one in Trancion Canyon were assessed as *functional at risk*. The six other examined reaches were determined to be *nonfunctional*.

FIGURE 1 - ROSGEN SCALE OF MAJOR STREAM TYPES

II. STUDY AREA DESCRIPTION

Three streams were monitored on Santa Rosa Island (Figure 2 below). Lobo Canyon starts on the north side of Black Mountain and flows to the north coast of the island. The upper portion of the canyon has only ephemeral flow. Cattle have been excluded from the lower portion of the drainage since 1992. Within the exclosure are excellent examples of relict riparian plant communities. Some areas support willows (*Salix lasiolepsis)* as well as cottonwood (*Populus fremontii*) and elderberry trees (*Sambucus mexicanus*). Other areas are dominated by sedges (*Carex* spp), rushes (*Juncus* spp*)*, and bulrushes (*Scirpus* spp). The channel morphology within the exclosure is a classic type E with a very high sinuosity, low width-to-depth ratio, and low channel slope. Channel morphology in the upper reaches reflects the steeper slopes and confinement of the drainage. Lobo Canyon is located within the North Pasture with the exception of the cattle exclosure.

Monitoring site Lobo #1 is located at the confluence of three tributaries at the base of Black Mountain (Figure 3 on the next page). This site rarely had adequate flow to monitor. Lobo #2 is located approximately 100 m above the Smith Hwy. This site had only intermittent flow and was only monitored during the height of the rainy season. Because Lobo #1 and #2 were monitored so infrequently, analysis of these two sites is not included in this report. The data collected from these two sites is presented in Appendix E. Lobo #3 is located 25 meters downstream from the oak grove below Smith Hwy. A perennial spring is located at the lower end of the oak grove. This site flowed throughout the inventory; however, flows became so low during the fall of 1994 that accurate discharge measurements were not possible. Lobo #4 is located near the lower end of the cattle exclosure. This site flowed throughout the study.

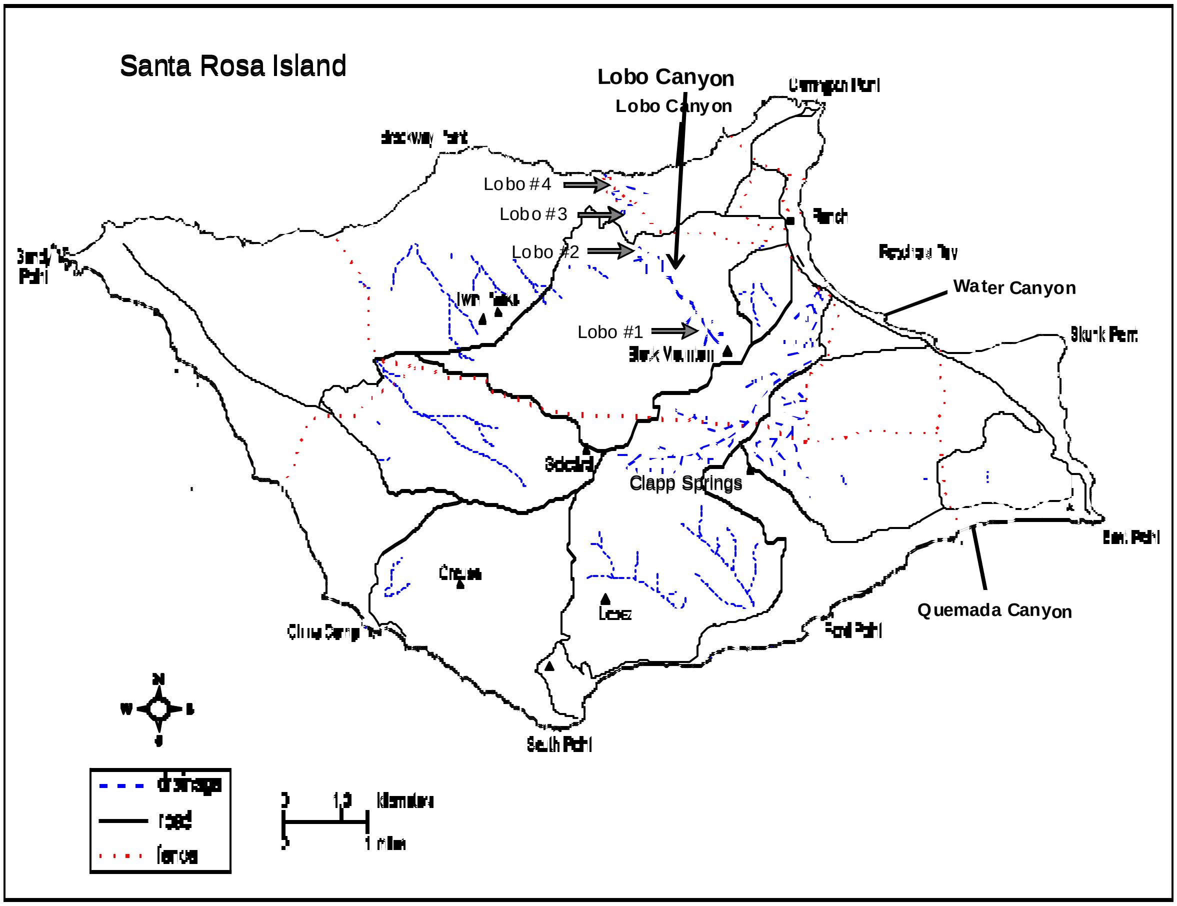


FIGURE 2 - STREAMS MONITORED ON SANTA ROSA ISLAND

Water Canyon starts from the central part of the island and flows east into Beecher's Bay (Figure 4 on the next page). A number of seeps and springs contribute to the flow. The majority of this drainage has perennial flow. The north side of the watershed is dominated by chaparral community. The rest of the drainage is dominated by annual grasslands. Water Canyon is located within two pastures. The majority of the drainage is located within the North Pasture. The extreme southwestern portion is located in the South Pasture. There are approximately a dozen willow plants located within this drainage.

The majority of the riparian areas within Water Canyon are in poor condition. Many of the stream's reaches are extremely entrenched. Width-to-depth ratios are very high. In most cases there is no definable bank. Riparian vegetation is dominated by saltgrass (*Distichlis spicata*), waterbent (*Agrostis semiverticillata*), and Bermuda grass (*Cynodon dactylon*). Shrubby vegetation is limited to inaccessible locations on cut banks. The majority of the drainage is downcut an average of 10 feet. Bank sheer and bank failure are common. The channel morphology in the lower reaches ranges from type G or F to type C on the Rosgen scale.

Water #1 is located above the Army Camp. It flowed only intermittently and rarely had enough discharge to accurately monitor. Results from Water #1 are not presented in this report although the data can be found in Appendix E. Water #2 located below Army Camp flowed throughout the rainy season, drying up in late May. Water #3 is located at the corral in lower Water Canyon. This site flowed throughout the study. Water #4 is located below the campground. This site is incised to bedrock. It flowed throughout the study.

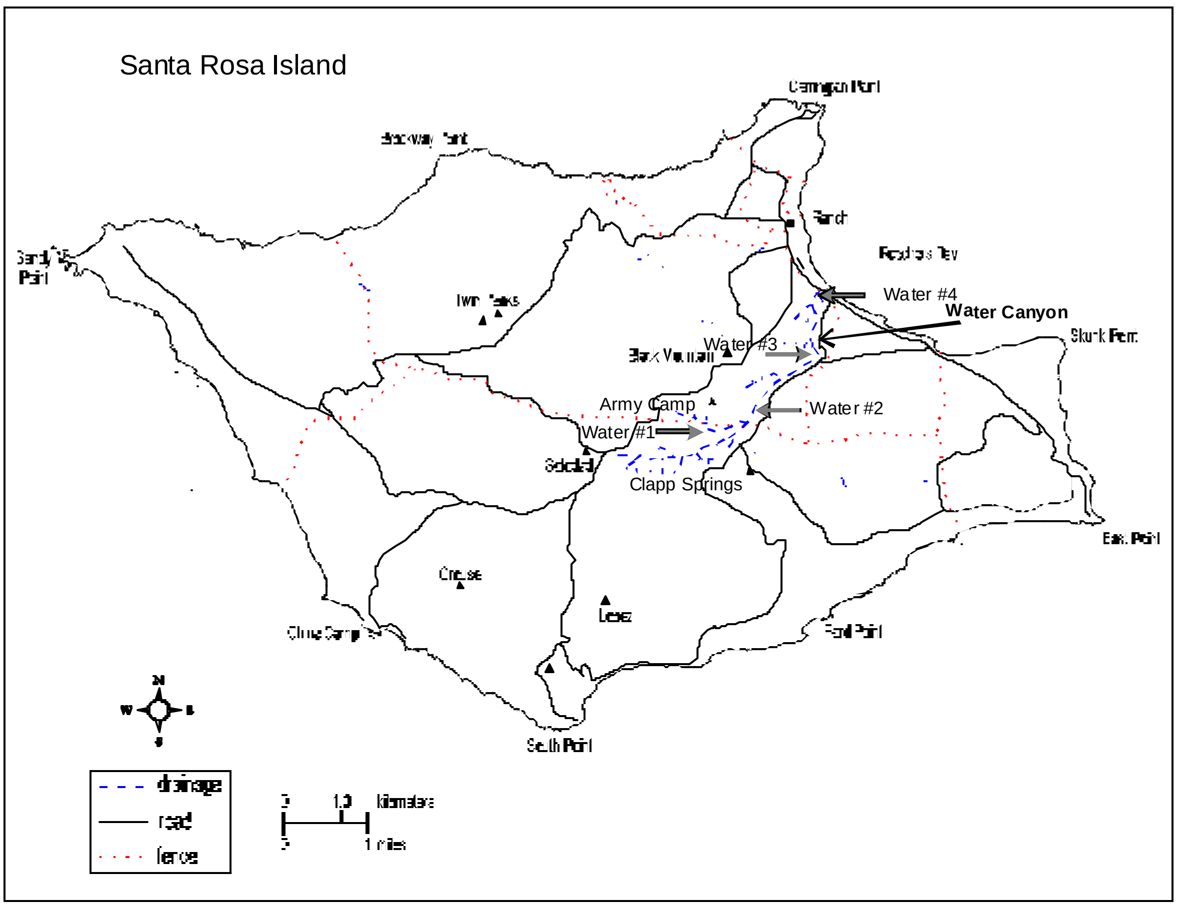


FIGURE 4 - SANTA ROSA MONITORING SITES

Quemada Canyon is the largest drainage studied (Figure 5 on the next page). Although there are a number of seeps and springs which augment its flow, the origin of the water in Quemada Canyon is a diverted spring — Clapp Springs — located in San Augustine Canyon. In the 1950's the ranch diverted the water from Clapp Springs creating a water development. The development is located on the ridge separating Quemada and San Augustine Canyon. The excess water from development is routed into Quemada Canyon. Quemada Canyon flows into Old Ranch Canyon and then into the ocean south of Skunk Point. The upper watershed of Quemada Canyon lies within the South Pasture. The middle section flows through the Wire Field Pasture. The lower section flows through Old Ranch Pasture. The majority of the stream in Quemada Canyon is deeply incised. Width-to-depth ratios are low. In most places the banks are not definable. In the upper reaches the riparian vegetation is dominated by waterbent, saltgrass, and Bermuda grass. In the lower reaches the riparian vegetation also contains pickleweed (*Salicornia virginica*) and Frankenia (*Frankenia salina*).

Quemada #1 is located approximately 50 meters below the water development. This site is not a natural channel. It is severely impacted by cattle. Due to lack of channel morphology and hoof sheer of the "banks", this site was essentially un-monitorable. Quemada #2 is located next to the Las Cruces corral. This site is severely entrenched, has poor stream bank definition, and poor riparian cover. The site flowed throughout the study. Quemada #3 is located next to the corral in Old Ranch Canyon. This site has some of the highest riparian cover percentages of any area in the drainage.

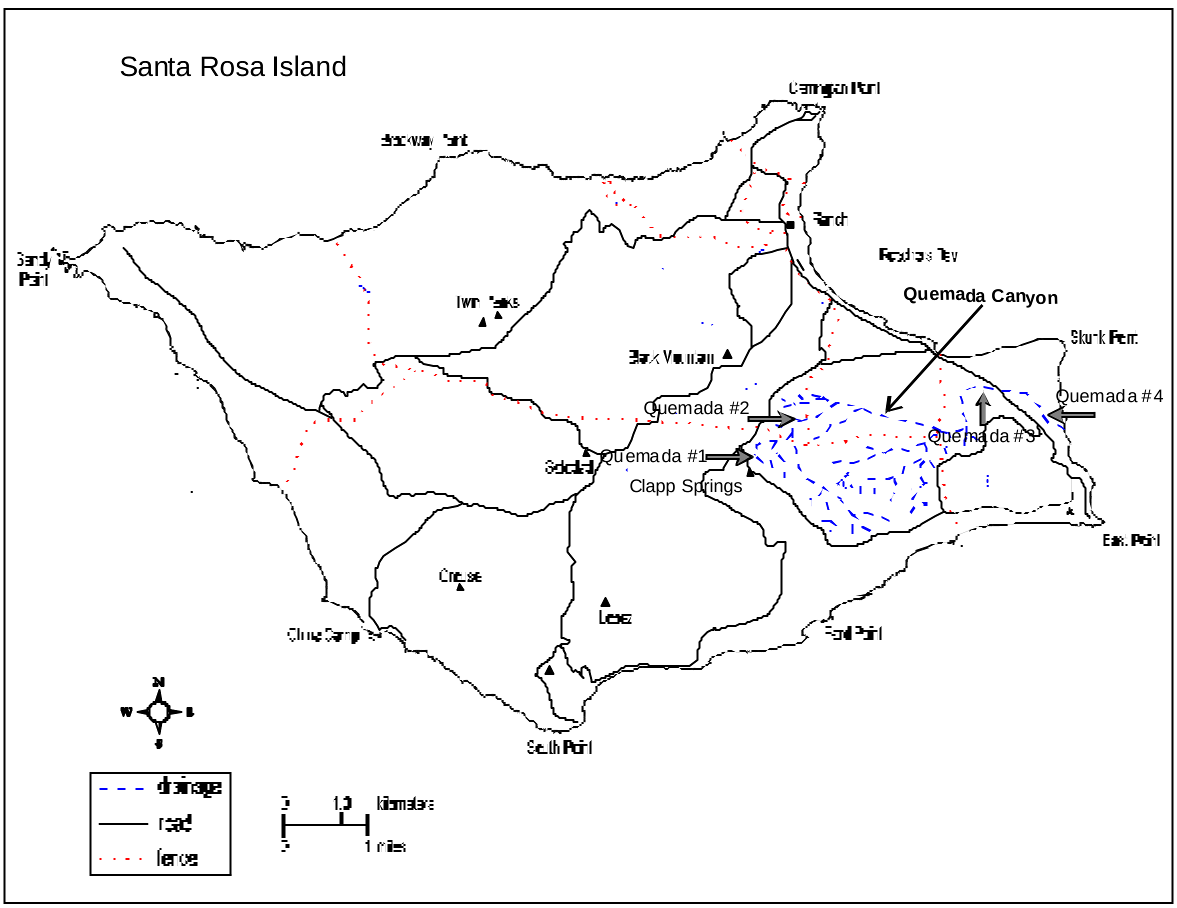


FIGURE 5 - QUEMADA CANYON MONITORING SITES

The riparian cover is dominated by saltgrass, pickleweed, and Frankenia. This site flowed perennially. Quemada #4 is located approximately one-half mile from the mouth of the stream. The site is highly impacted by cattle. There is little riparian vegetation and no definable bank. This stream reach has a high width-to-depth ratio. This site dried up in June, 1994 and discharge had not increased significantly enough to gather measurements by December, 1994.

III. METHODS

Monitoring of water quality occurred every two weeks when possible. At each site discharge, air and water temperature, pH, conductivity, salinity, turbidity, and dissolved Oxygen were measured. The velocity was measured using a Marsh McBirney Flowmate 2000. Measurement increments were usually 0.5 feet. Depth was measured using a top setting rod. Calculations of discharge were made by multiplying the depth (at each increment) times width (of each increment) times velocity (measured by the Flowmate 2000). The discharge for each increment was then summed to give the discharge for the cross section of the stream. The air temperature was measured using an analog thermometer placed in the shade. All other parameters were measured using the Horiba U-10 water quality checker. The Horiba U-10 was manually calibrated prior to the monitoring trip and automatically calibrated at the beginning of each day. See Appendix A for details on the calibration protocols.

At the #3 site for each drainage, samples of water were taken for later analysis by a contracted laboratory. The laboratory analyzed the water for total Nitrogen, total Phosphorous, total dissolved solids, total suspended sediments, total coliform, and fecal coliform. Water samples for analysis of total Nitrogen, total Phosphorus, total dissolved solids, and total suspended sediments were collected at the time of monitoring of other parameters. Fecal coliform water samples were collected on the day of travel. All water samples were placed in a cooler with ice packs and later (if applicable) in the refrigerators in the trailers on the islands. Samples were immediately taken to the contracted laboratory upon arrival on the mainland. See Appendix C for laboratory analysis protocols.

Several attempts were made to monitor discharge and sediments during significant storm events. Storm event monitoring required the sampler to accurately predict the incoming storm in terms of time and severity. The sampler then traveled to the monitoring site (usually a #3 site) and set up camp. Initial measurements were made prior to the arrival of the storm. Once the storm began, measurements of discharge were made and samples of water were taken every four hours for the duration of the storm. Monitoring continued until twelve hours after the last significant precipitation event. The sampler then backpacked from the site back to the trailer court in Beecher's Bay. Water samples were held in the trailer's refrigerator until transportation off the island could be secured. Water samples were taken to the contracted laboratory and analyzed for total dissolved solids and total suspended sediments.

Database design and data entry were contracted out to a local firm who had been working with the park on related issues. The local firm created the design and database using Microsoft Access 2.0. This facilitated easy transfer of data to Microsoft Excel, FoxPro and Word. Excel and Systat were used to analyze the data set. Plans are being made for the data set to join the STORET data set of nationwide water quality information.

Statistical analysis was conducted on the parameters. Research questions included: Is the data for each parameter normally distributed? Is the sample size adequate for desired precision and accuracy? Is there a significant difference between sites within a drainage for different parameters? Are there significant differences between drainages for different parameters? All tests were conducted using a significance value (*p)* of 0.20. This is a standard level of significance used by land management agencies.

IV. RESULTS

Twelve sites in three drainages were monitored for physical, chemical, and biological parameters every two weeks over a fifteen-month period. Several sites were not monitored over the entire period due to lack of sufficient water flow. Results from sites Lobo #1, Lobo #2, Water #1, and Quemada #1 are not discussed in this report because of insufficient data for analysis. Results from the remaining sites are presented in tables of descriptive statistics, box and whisker diagrams, analysis of trend graphs, and non-parametric comparisons of sites and drainages. Results represent all routine monitoring samples from the inventory.

A. DESCRIPTIVE STATISTICS

Tables of statistical summaries are presented on the next several pages. Each Table displays the number of observations (n), the median value of the population (M), the variance (s^2), the standard deviation(s), and whether the data is normally distributed. Tests of normalcy were conducted using separate tests of the g_1 (symmetry) and g_2 (kurtosis) statistics. The population had to be symmetrical and mesokurtokic for the population to be considered normally distributed.

Box and Whisker Graphs are also presented. These plots present a great deal of data in a single plot. The center horizontal line within the box represents the median. The upper and lower box edges are called *hinges* and represent the 25th and 75th percentiles respectively. The vertical lines extending above and below the box are called *whiskers*. The whiskers show the range of values that falls within 1.5 * (upper hinge - lower hinge). Asterisks (*) are those values that fall between 1.5 * (upper hinge - lower hinge) and 3.0 * (upper hinge - lower hinge). The empty circles are those values that lie beyond the 3.0 * (upper hinge - lower hinge) barrier. The asterisks are sometimes called *outliers* while the empty circles are sometimes called *far outliers* (Wilkenson, *et*

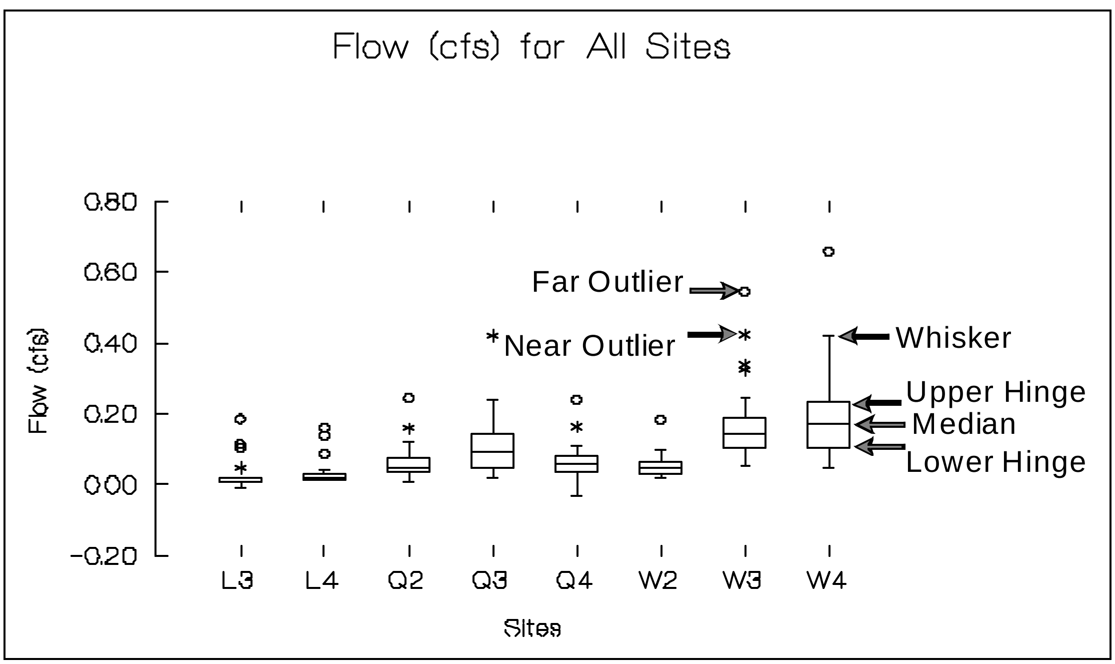


FIGURE 6 - EXAMPLE OF BOX AND WHISKER GRAPH

al, 1992).

1. DISCHARGE

Discharge is a measure of the volume of water which flows past an imaginary vertical plane within the water column every second. (Stednick, 1991) It is measured in situ with the Marsh McBirney Flowmate 2000 and a top setting rod. The units of measure are cubic feet per second (cfs).

TABLE 1 - DESCRIPTIVE STATISTICS FOR DISCHARGE (CFS)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	25	0.009	.002	.045	No
Lobo #4	25	0.022	.002	.039	No
Water #2	15	0.047	.002	.043	No
Water #3	26	0.142	.013	.116	No
Water #4	25	0.198	.019	.140	No
Clapp Springs	N/A	N/A	N/A	N/A	N/A
Quemada #2	22	0.050	.003	.052	No
Quemada #3	25	0.095	.008	.089	No
Quemada #4	17	0.061	.004	.065	No

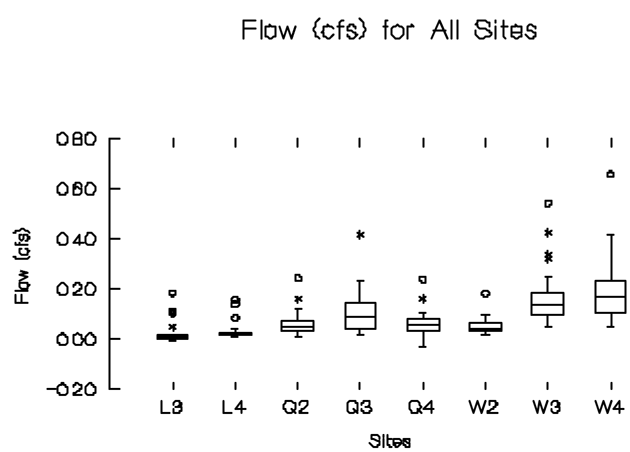


FIGURE 7 - DISCHARGE (CFS) FOR ALL SITES

2. WATER TEMPERATURE

Water temperature is measured in situ using the Horiba U-10 water quality checker. The units of measure is degrees centigrade (C).

TABLE 2 - DESCRIPTIVE STATISTICS FOR WATER TEMPERATURE (C)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	26	16.40	4.746	2.179	Yes
Lobo #4	25	16.50	10.300	3.209	Yes
Water #2	15	15.50	19.917	4.63	Yes
Water #3	26	20.60	26.697	5.167	Yes
Water #4	25	18.70	26.653	5.163	Yes
Clapp Springs	21	17.20	7.975	2.824	Yes
Quemada #2	22	16.70	25.874	5.087	No
Quemada #3	25	19.31	20.962	4.578	Yes
Quemada #4	17	21.10	11.487	3.389	Yes

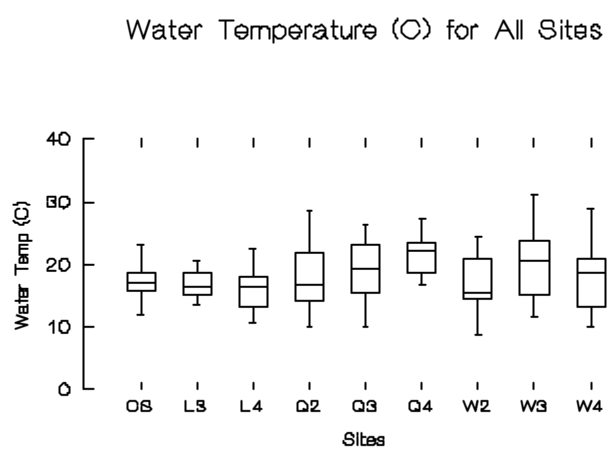


FIGURE 8 - WATER TEMPERATURE (C)

3. pH

pH is a measure of the concentration of hydrogen ions. It is measured in situ using the Horiba U-10 water quality checker. Because pH is a log transformation of H+ ion concentration, statistics cannot be performed on the data without transforming the data back to H+ ion concentration. The statistics below are for microequivalents (µeq) of H+ ions.

TABLE 3 - DESCRIPTIVE STATISTICS FOR PH (µEQ)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	26	0.062	0.001	0.025	No
Lobo #4	25	0.013	0.000	0.012	No
Water #2	15	0.008	0.001	0.031	No
Water #3	26	0.006	0.000	0.022	No
Water #4	25	0.004	0.000	0.001	No
Clapp Springs	21	0.007	0.000	0.003	No
Quemada #2	22	0.007	0.000	0.002	No
Quemada #3	25	0.005	0.000	0.004	No
Quemada #4	17	0.007	0.002	0.050	No

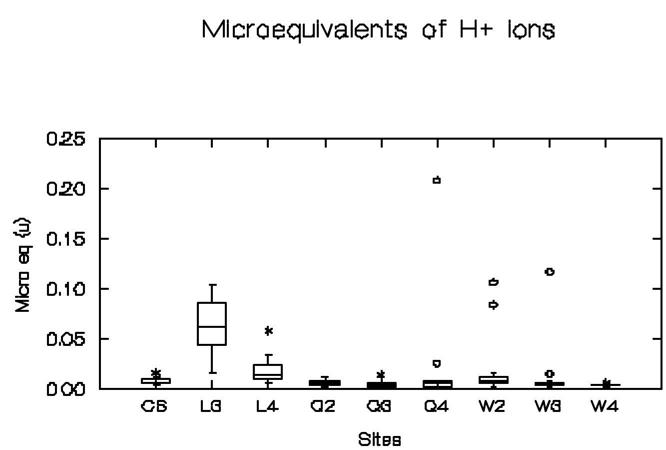


FIGURE 9 - MICROEQUIVALENTS OF H+ IONS FOR ALL SITES

4. CONDUCTIVITY

Conductivity is a measure of the ability of the water to convey an electrical current. It is related to the total concentration of ionized substances, their concentrations, mobility, and valences. Conductivity is one way to estimate the total dissolved solids, although it does not reflect non-conductive compounds such as organic molecules which do not dissociate in water (Stednick, 1991). Conductivity was measured in situ with the Horiba U-10. The units of measure is milliSiemen per centimeter (mS/cm).

TABLE 4 - DESCRIPTIVE STATISTICS FOR CONDUCTIVITY (MS/CM)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	26	2.385	.128	.358	No
Lobo #4	25	2.480	.085	.292	No
Water #2	15	3.080	.371	.609	No
Water #3	26	2.475	.038	.194	No
Water #4	25	2.520	.033	.182	No
Clapp Springs	21	0.498	0	.011	Yes
Quemada #2	22	3.885	.350	.591	No
Quemada #3	25	4.140	.133	.364	Yes
Quemada #4	17	4.370	.112	.334	Yes

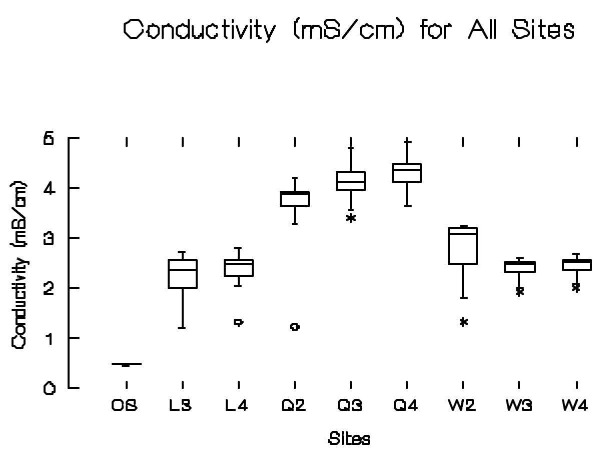


FIGURE 10 - CONDUCTIVITY (MS/CM) FOR ALL SITES

5. SALINITY

Salinity is closely related to conductivity. Salinity measures the concentration of sodium (Na+) and chloride (Cl-) ions. It is calculated based on conductivity measurements by the Horiba U-10. The units of measure is percent (%).

TABLE 5 - DESCRIPTIVE STATISTICS FOR SALINITY (%)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	25	0.110	.000	.019	No
Lobo #4	25	0.120	.000	.015	No
Water #2	15	0.150	.001	.026	No
Water #3	26	0.110	.000	.011	No
Water #4	25	0.120	.000	.010	No
Clapp Springs	21	0.020	.000	.004	No
Quemada #2	22	0.182	.001	.032	No
Quemada #3	25	0.210	.000	.020	Yes
Quemada #4	17	0.220	.000	.019	Yes

Salinity (%) for All Sites

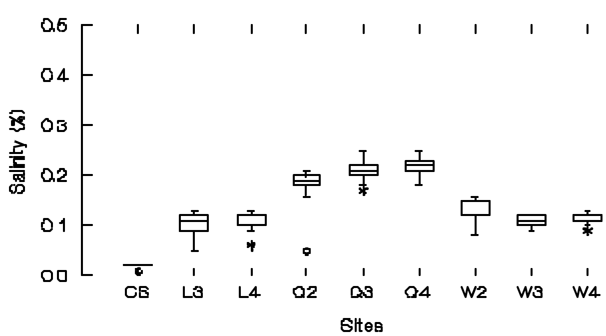


FIGURE 11 - SALINITY (%) FOR ALL SITES

6. DISSOLVED OXYGEN

Dissolved Oxygen (DO) is a measure of the amount of soluble Oxygen in the water. Since Oxygen does not react chemically with water, the exposure of the water to the air and the amount of atmospheric pressure is the major determining factor in the amount of dissolved Oxygen. Byproducts of photosynthesis can also play an important role. Dissolved Oxygen is a very transient property. Diurnal changes can vary up to 10 mg/l (Stednick, 1991). It was measured in situ with the Horiba U-10. The units of measure is milligrams per litre (mg/l).

TABLE 6 - DESCRIPTIVE STATISTICS FOR DISSOLVED OXYGEN (MG/L)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	26	9.44	.835	.914	Yes
Lobo #4	25	10.59	.831	.912	Yes
Water #2	15	10.51	2.145	1.465	Yes
Water #3	26	10.25	1.166	1.080	Yes
Water #4	25	10.93	1.417	1.190	No
Clapp Springs	21	8.670	1.399	1.183	Yes
Quemada #2	22	10.85	2.398	1.549	No
Quemada #3	25	13.00	10.789	3.285	No
Quemada #4	17	11.284	2.222	1.491	Yes

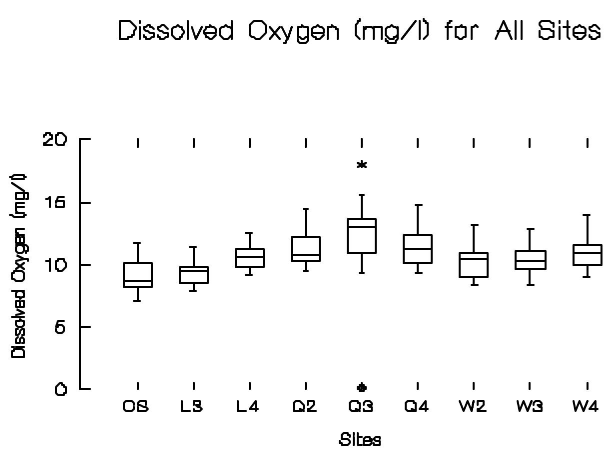


FIGURE 12 - DISSOLVED OXYGEN (MG/L) FOR ALL SITES

7. TURBIDITY

Turbidity is a measure of the clarity of water. Turbidity is an optical property that causes light waves to be scattered upon contacting the water rather than transmitting directly through it. The light is scattered due to particles in the water blocking the path of the light wave (Stednick, 1991). Turbidity is measured in situ by the Horiba U-10. The units of measure is the Nephelometric Turbidity Unit (NTU). The higher the NTU value, the less clear (or more turbid) the water is.

TABLE 7 - DESCRIPTIVE STATISTICS FOR TURBIDITY (NTU)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	24	1.000	16.955	4.118	No
Lobo #4	24	3.000	423.993	20.591	No
Water #2	15	7.000	40.600	4120.543	No
Water #3	25	35.00	11119	105.445	No
Water #4	24	8.000	8621	92.849	No
Clapp Springs	20	2.500	15.937	3.992	No
Quemada #2	21	11.00	17388	131.865	No
Quemada #3	24	2.000	590.172	24.293	No
Quemada #4	17	6.000	366.684	19.149	No

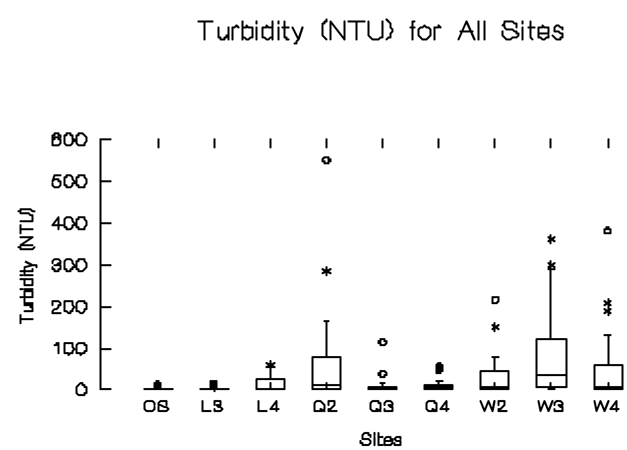


FIGURE 13 - TURBIDITY (NTU) FOR ALL SITES

8. NUTRIENTS

There are two measurements of nutrients in the water which are taken. The first is Total Nitrogen which is the sum of the concentrations of ammonia (NH_3) as ammonium (NH_4^+), nitrite (NO_2^-), and nitrate (NO_3) (Stednick, 1991). The units of measure is milligrams per litre (mg/l).

The second index of nutrients is Total Phosphorus. Total Phosphorus is the sum total of orthophosphate (PO_4^{3-} and HPO_4^{2-}), condensed phosphates (pyro-, poly-, and meta-phosphates), and organic phosphates. Both parameters measure organic pollution in the water. (Stednick, 1991). The units of measure is milligrams per litre (mg/l).

Water samples were collected in sterilized bottles provided by the contracted laboratory, preserved with H_2SO_4, stored in a refrigerator on the island, transported to the lab, and analyzed there. See Appendix C for an explanation of the analysis techniques.

TABLE 8 - TOTAL NITROGEN (MG/L)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	25	1.044	0.473	.688	No
Water #3	25	.620	0.110	.332	No
Quemada #3	24	.646	0.054	.232	No

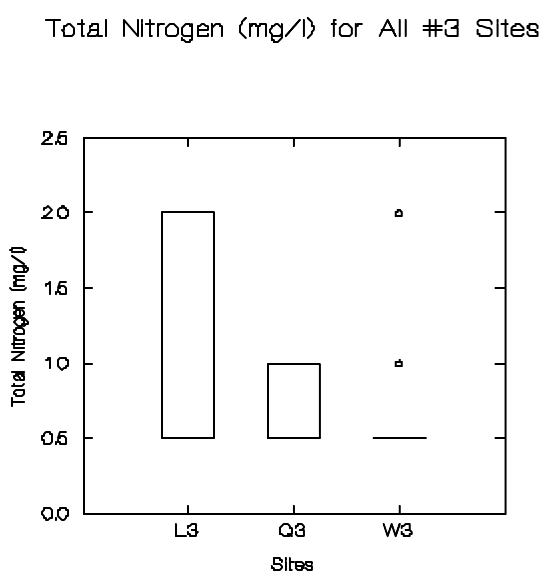


FIGURE 14 - TOTAL NITROGEN (MG/L) FOR ALL #3 SITES

TABLE 9 - TOTAL PHOSPHORUS (MG/L)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	25	.120	.015	.123	No
Water #3	25	.288	.106	.326	No
Quemada #3	24	.204	.067	.258	No

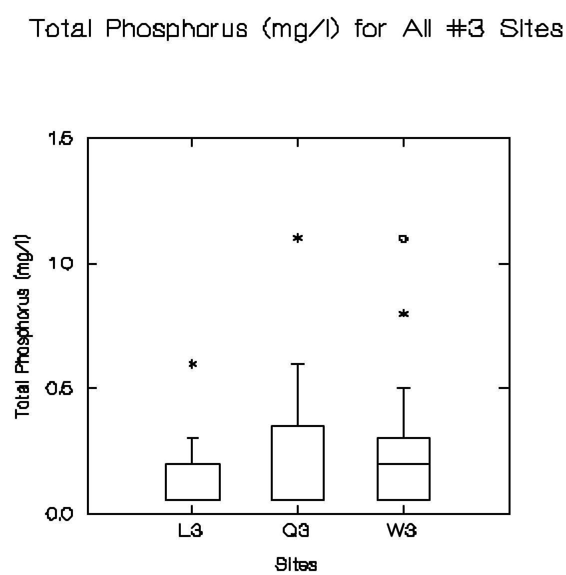


FIGURE 15 - TOTAL PHOSPHORUS (MG/L) FOR ALL #3 SITES

9. TOTAL DISSOLVED SOLIDS

Total dissolved solids (TDS) are a measure of dissolved elements, usually salts. They are closely related to conductivity and salinity. TDS were sampled with bottles provided by the contract laboratory, stored on the island within a refrigerator, and transported to the contract laboratory. The units of measure is milligrams per litre (mg/l). See Appendix C for details on the laboratory analysis procedures.

TABLE 10 - TOTAL DISSOLVED SOLIDS (MG/L)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	25	1580	39775	199.437	Yes
Water #3	25	1500	21047	145	Yes
Quemada #3	24	2735	82600	287.4	Yes

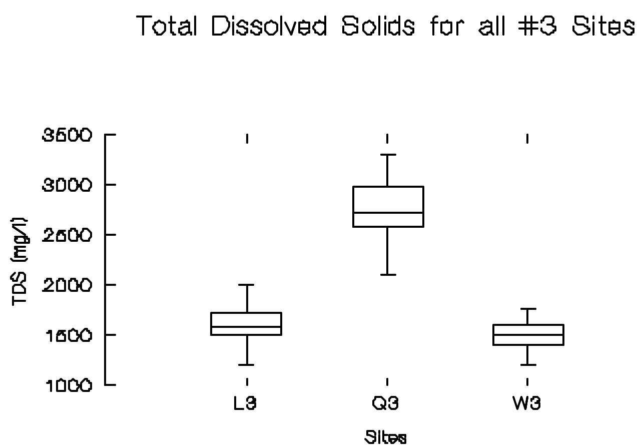


FIGURE 16 - TOTAL DISSOLVED SOLIDS FOR ALL #3 SITES

10. TOTAL SUSPENDED SEDIMENTS

Total suspended sediments (TSS) are closely related to turbidity. They are usually fine particles which do not react with water. TSS were sampled with bottles provided by the contract laboratory, stored on the island within a refrigerator, and transported to the contract laboratory. The units of measure is milligrams per litre (mg/l). See Appendix C for details on the laboratory analysis procedures.

TABLE 11 - TOTAL SUSPENDED SEDIMENTS (MG/L)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	25	5.000	17.750	4.213	No
Water #3	25	30.00	2832	53.22	No
Quemada #3	24	5.000	10.145	3.185	No

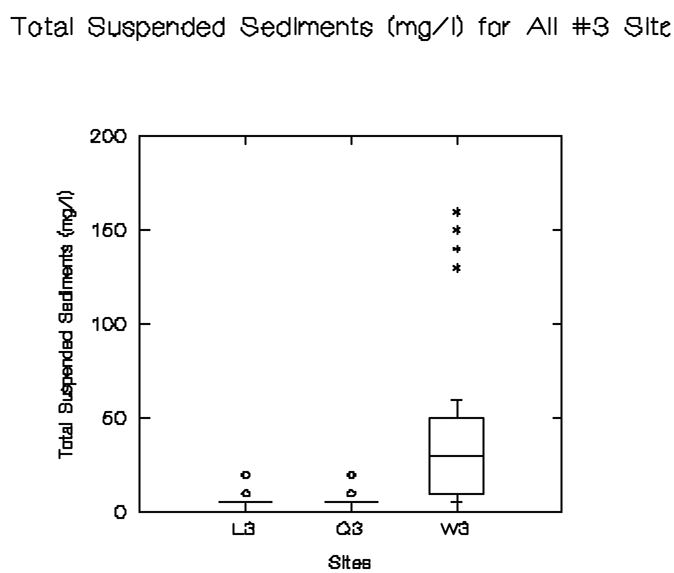


FIGURE 17 - TOTAL SUSPENDED SEDIMENTS FOR ALL #3 SITES

11. COLIFORM

Coliform bacteria is an important group of bacteria used to assess the sanitary quality of streams. There are two types of coliform bacteria measured on Santa Rosa, *total* and *fecal* coliform. Total coliform bacteria includes fecal coliform as well as other coliform bacteria. Fecal coliform are those bacteria discharged from the digestive tracks of mammals in feces (Stednick, 1991).

Samples of bacteria are always taken the day of island transportation due to the short six-hour holding time. Grab samples are taken using sterilized and sealed bottles provided by the contract laboratory. Samples are stored in a cooler and immediately taken to the contract laboratory for analysis. Results shown below and on the next page are for the entire inventory, not for any 30-day period within the study. The units of measure is Most Probable Number per 100 milliliters (MPN/100ml).

TABLE 12 - TOTAL COLIFORM (MPN/100ML)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	19	571.8	4.523×10^5	672.6	No
Water #3	19	3141	3.945×10^7	6281	No
Quemada #3	19	1895	3.110×10^8	17,635	No

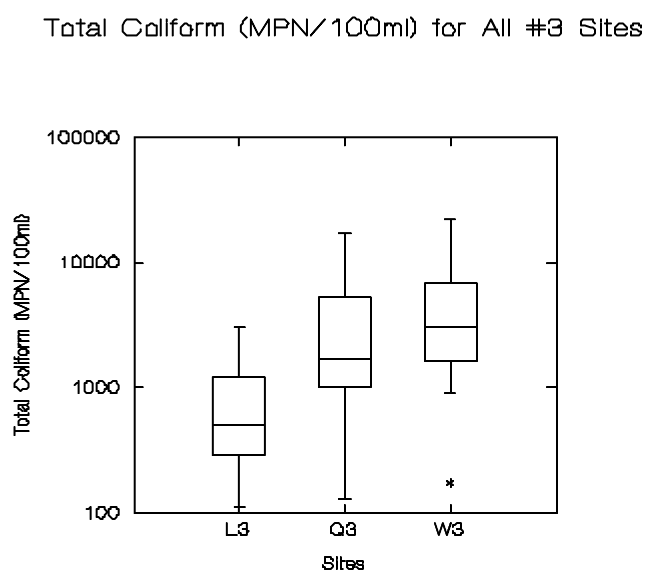


FIGURE 18 - TOTAL COLIFORM FOR ALL #3 SITES

TABLE 13 - FECAL COLIFORM (MPN/100ML)

SITE	# OF OBSERVATIONS	MEDIAN	VARIANCE	STANDARD DEVIATION	NORMALLY DISTRIBUTED?
Lobo #3	19	169	3.936×10^5	627.4	No
Water #3	19	1501	1.675×10^7	4,093	No
Quemada #3	19	1249	1.052×10^7	3243	No

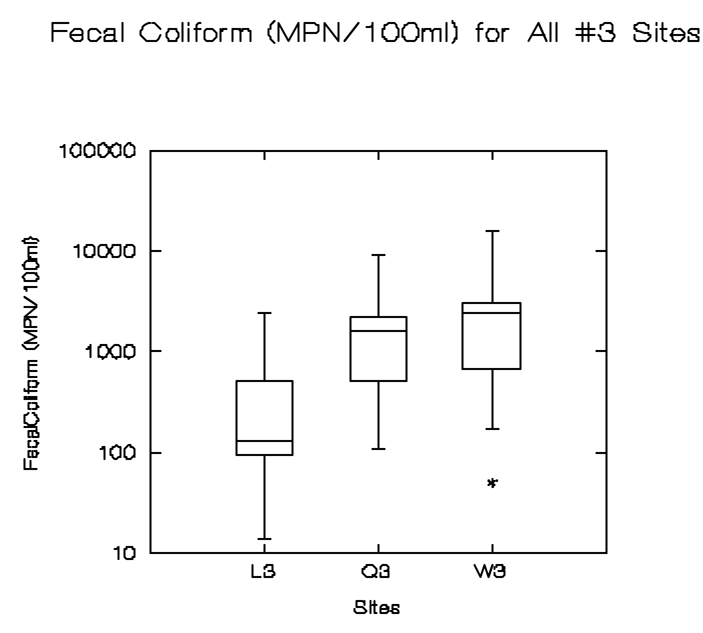


FIGURE 19 - FECAL COLIFORM FOR ALL #3 SITES

B. TREND ANALYSIS

The Figures on the following nine pages (Pages 27-35) show how different variables have changed over time:

- Each Figure consists of a set of graphs depicting various aspects of nine tracked variables.
- It is important to note that each site has a different scale.
- The time line has been corrected for periods when parameters were not monitored.

1. DISCHARGE

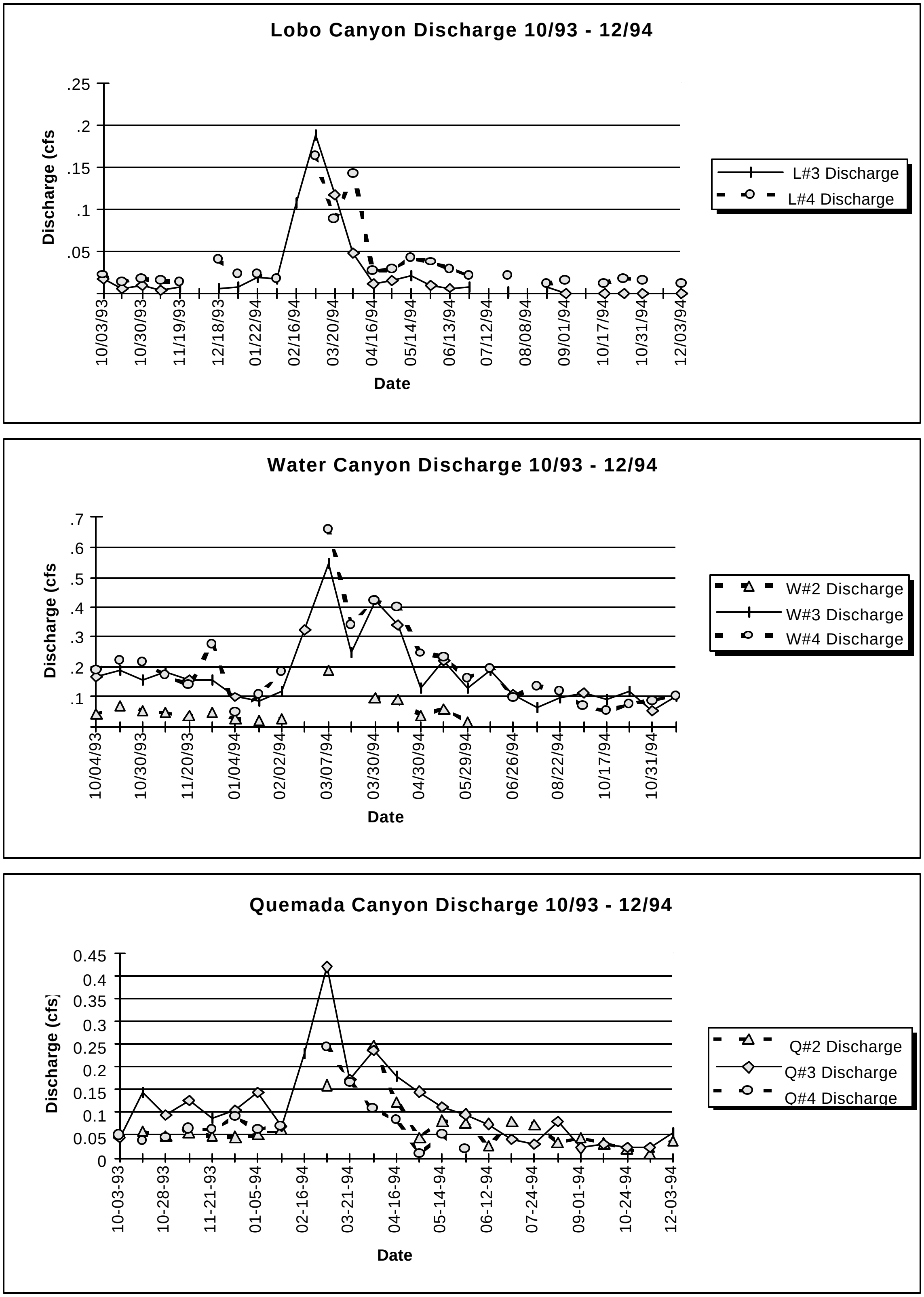


FIGURE 20 - DISCHARGE TRENDS

2. WATER TEMPERATURE

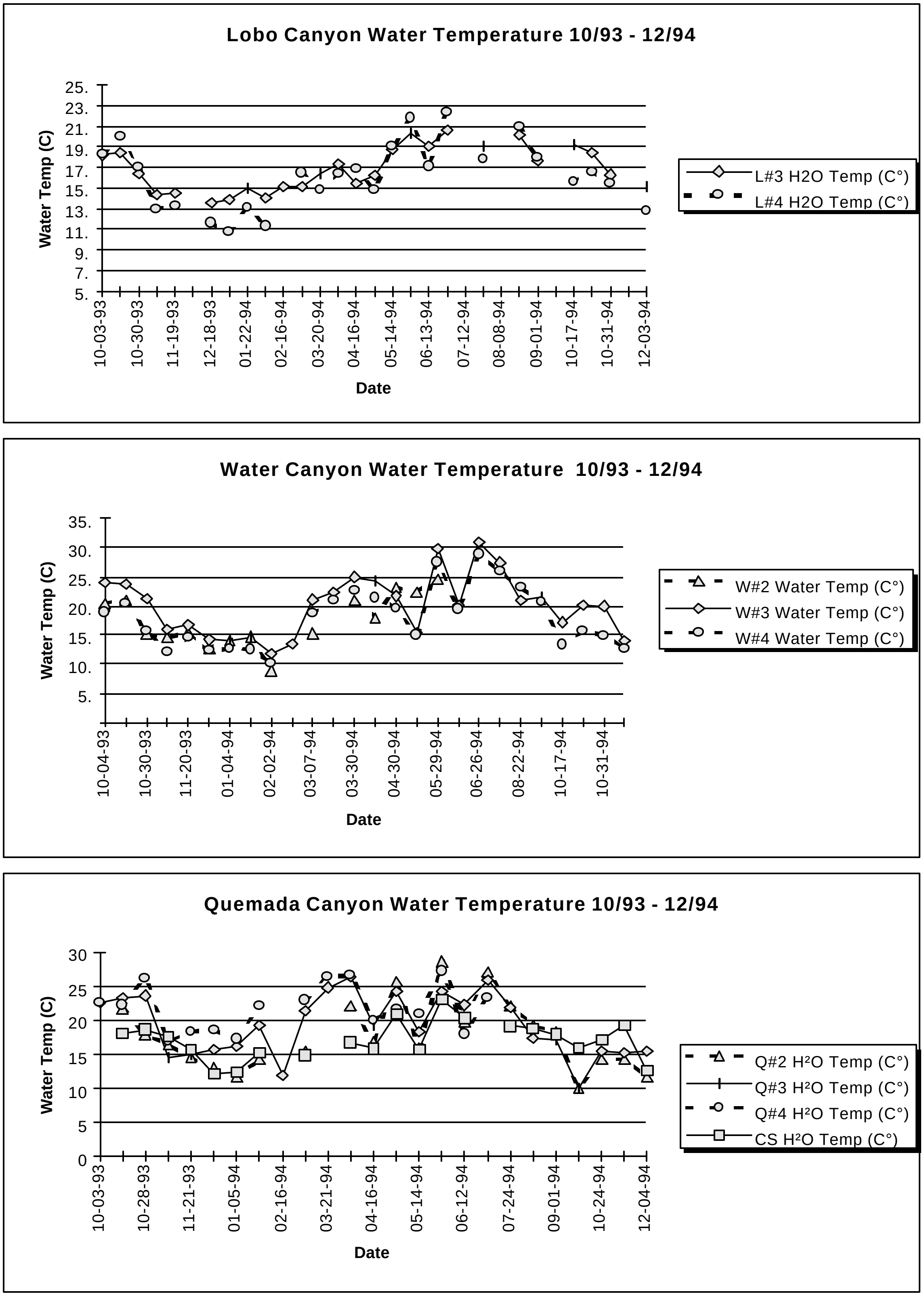


FIGURE 21 - WATER TEMPERATURE TRENDS

3. pH

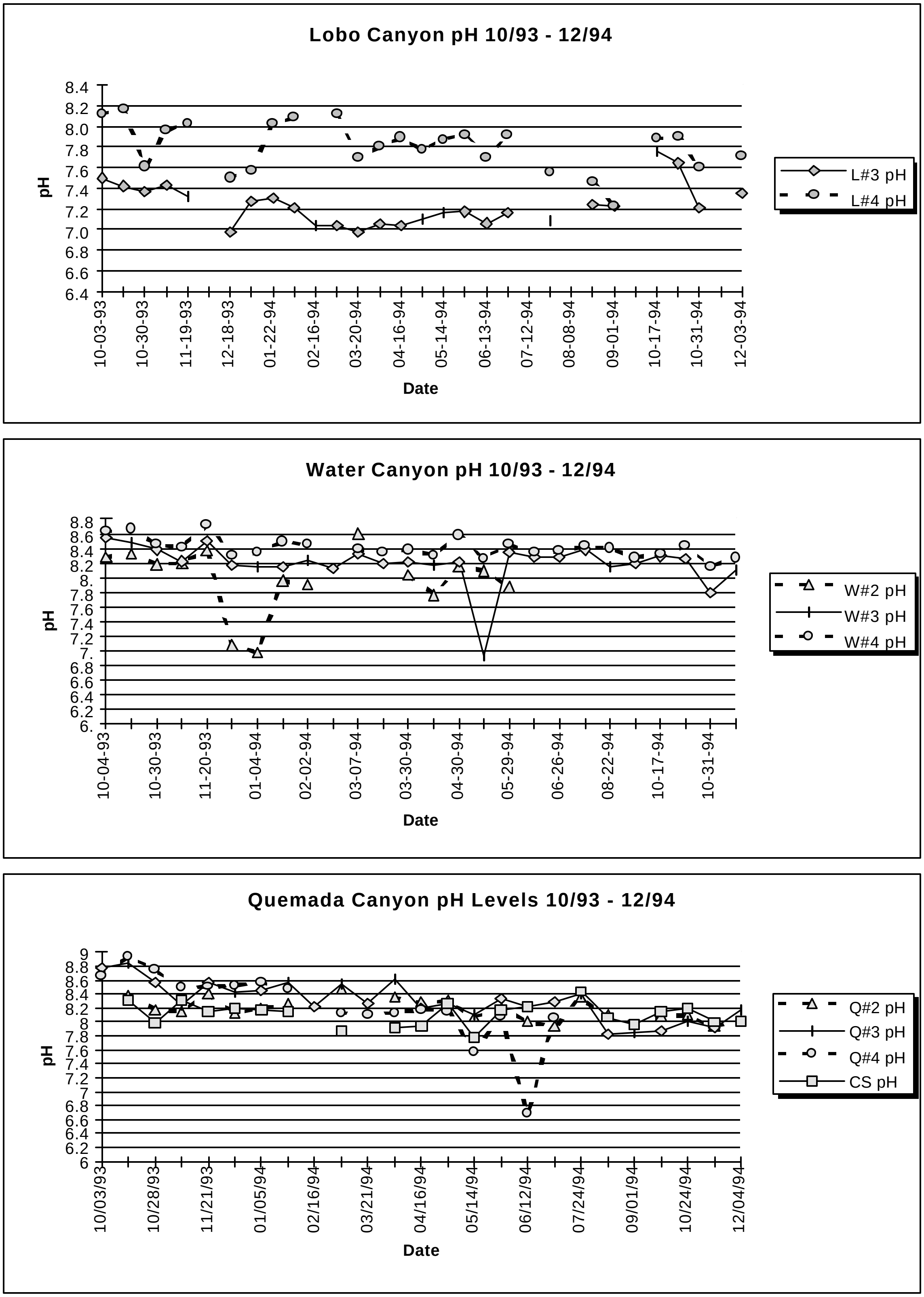


FIGURE 22 - PH TRENDS

4. CONDUCTIVITY

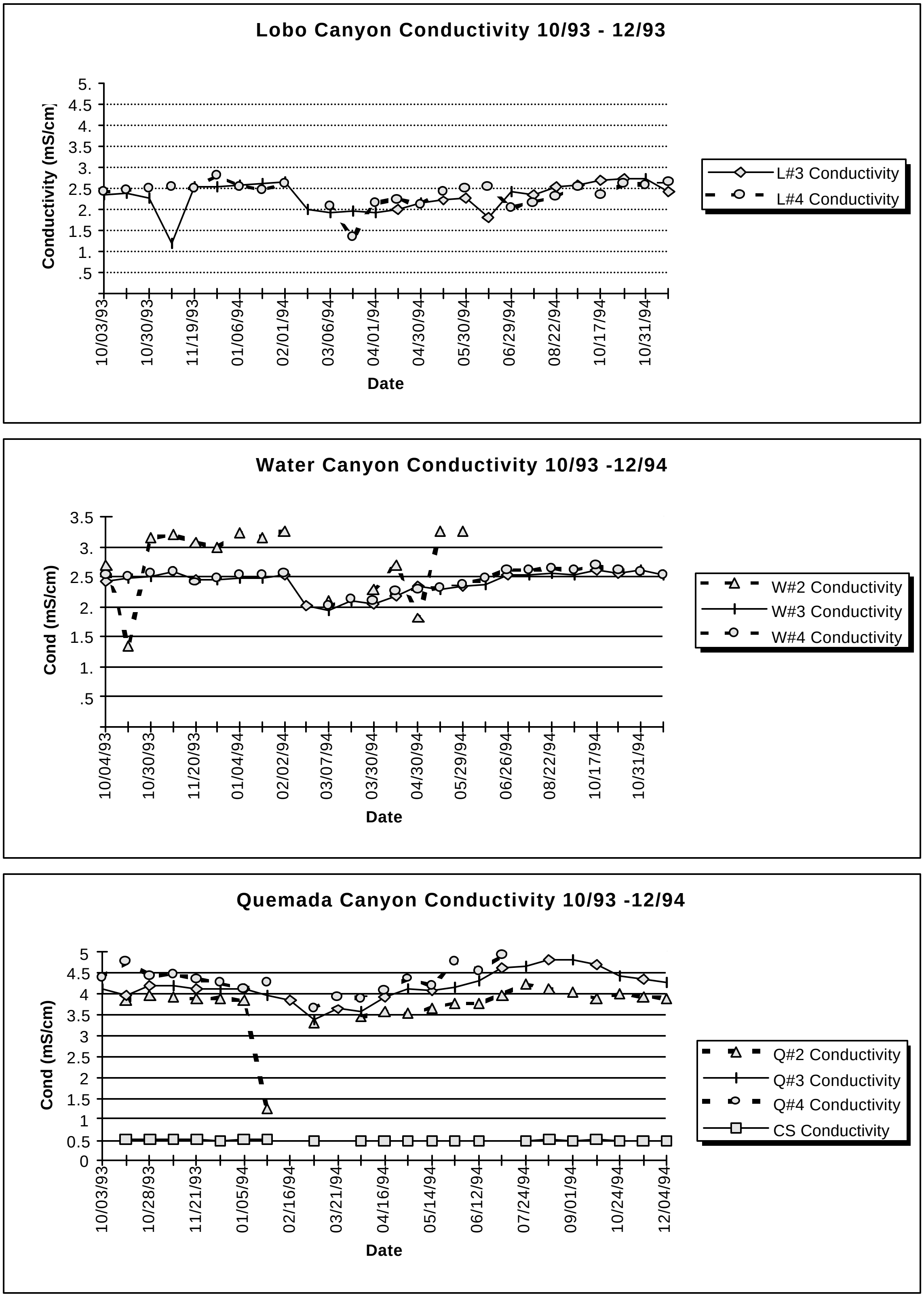
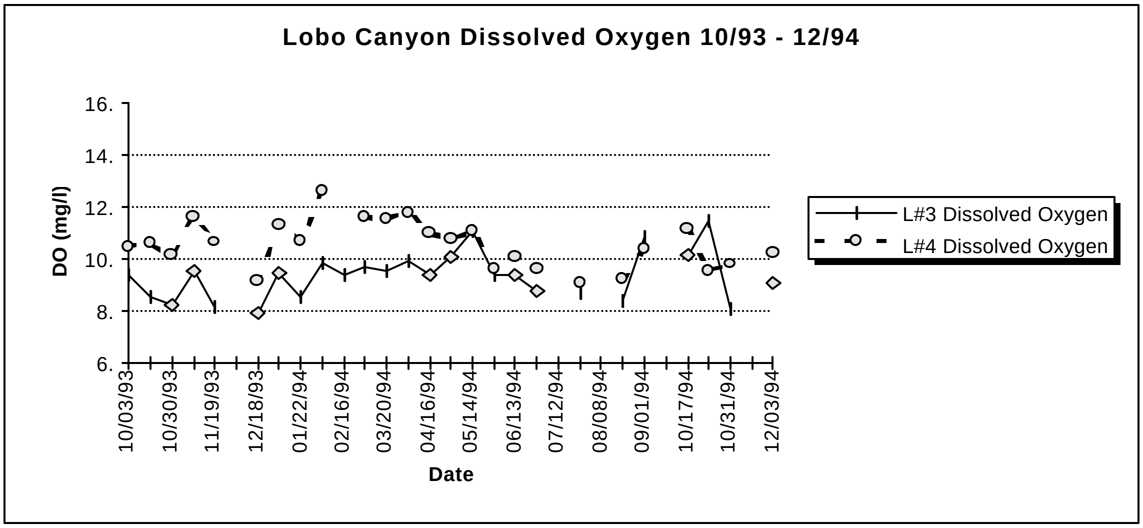
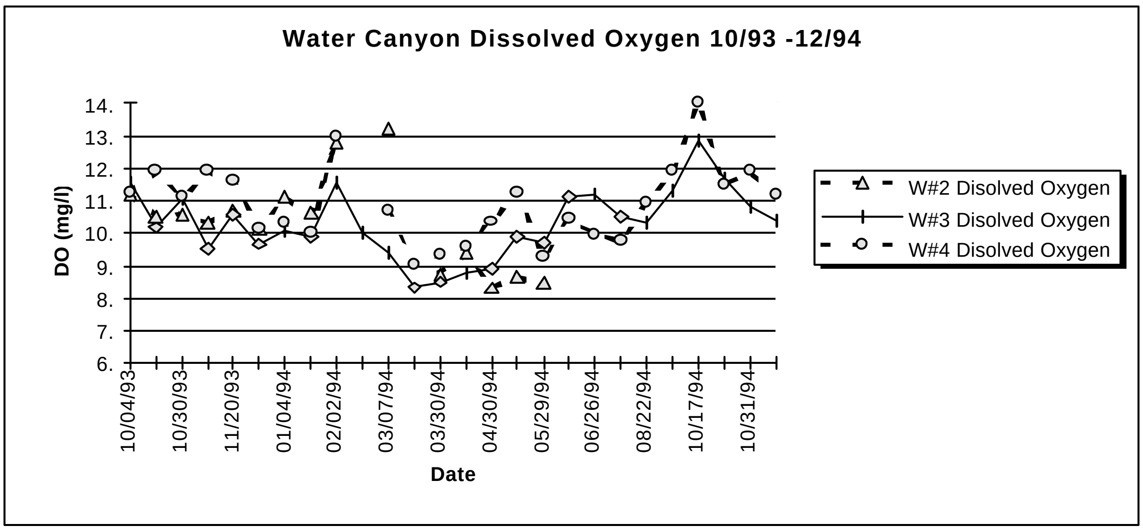


FIGURE 23 - CONDUCTIVITY TRENDS

5. DISSOLVED OXYGEN





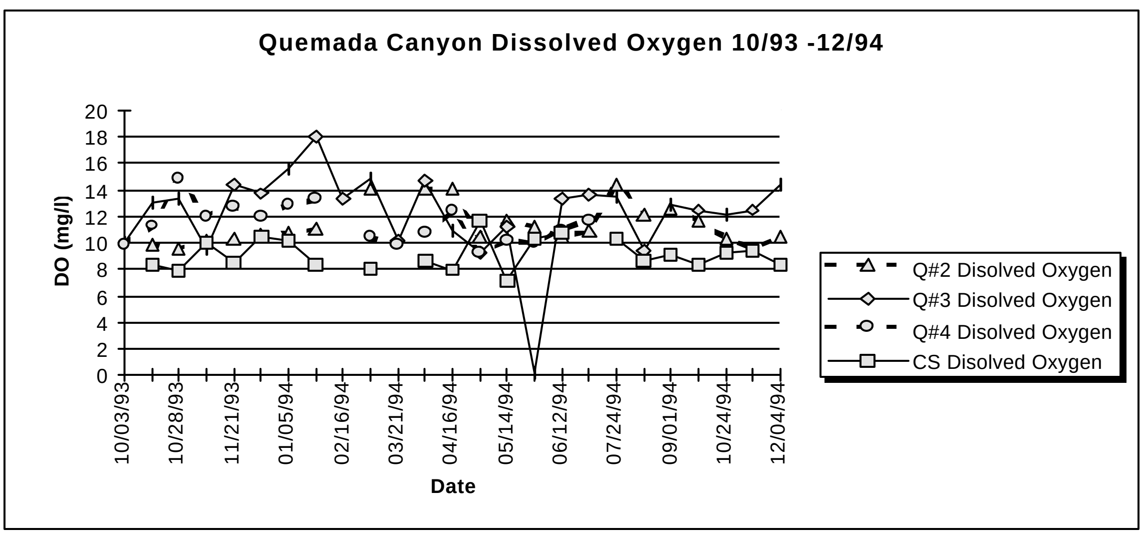


FIGURE 24 - DISSOLVED OXYGEN TRENDS

6. TURBIDITY

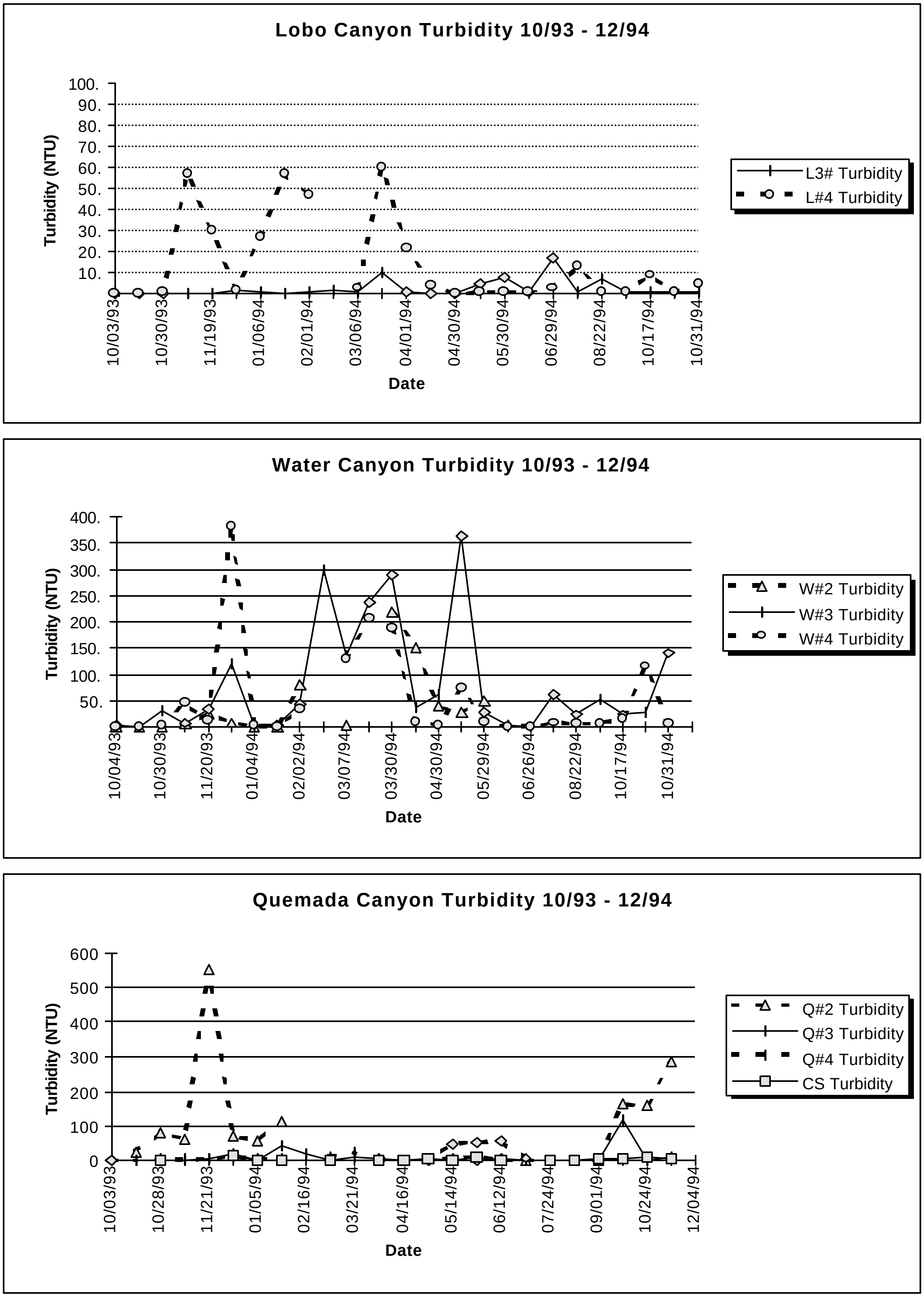
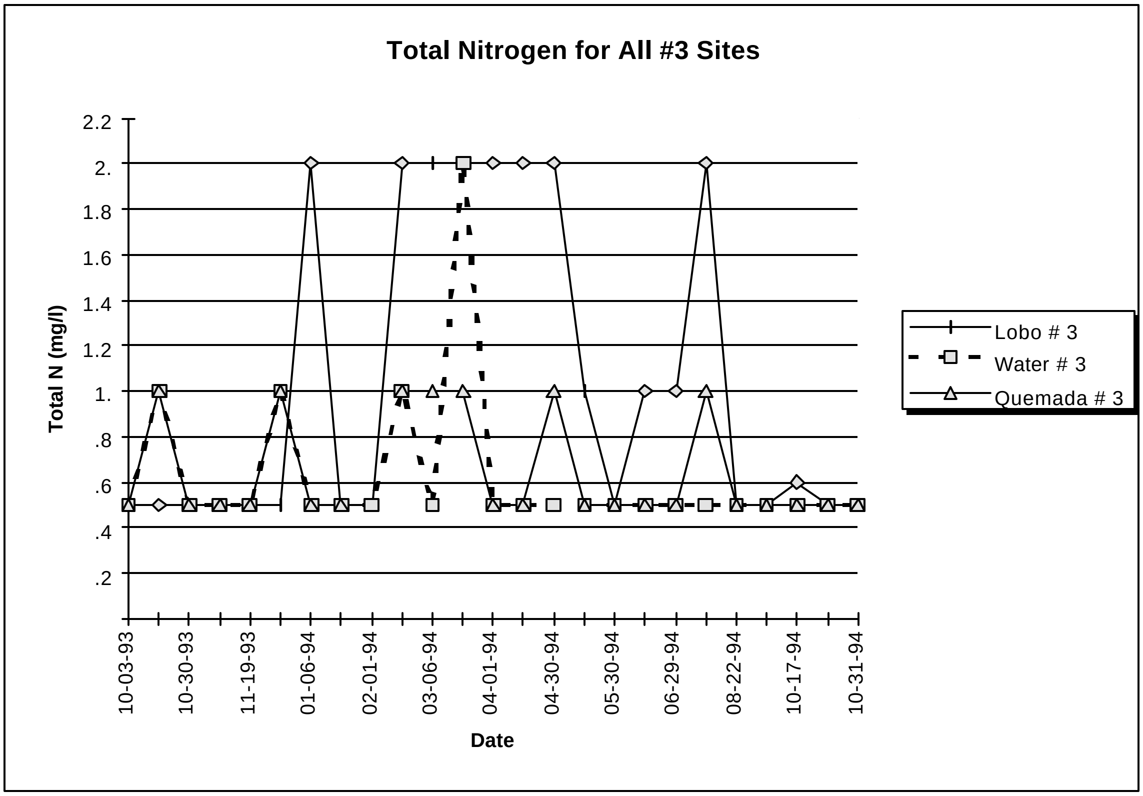


FIGURE 25 - TURBIDITY TRENDS

7. NUTRIENTS



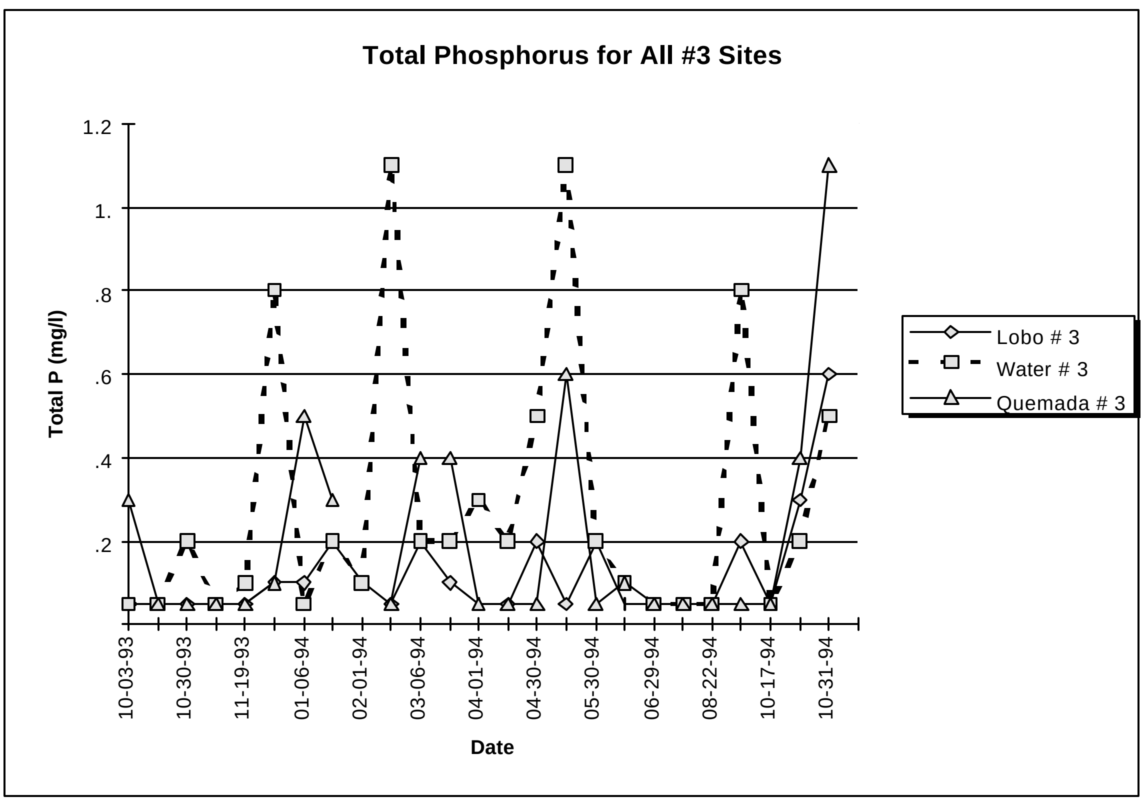
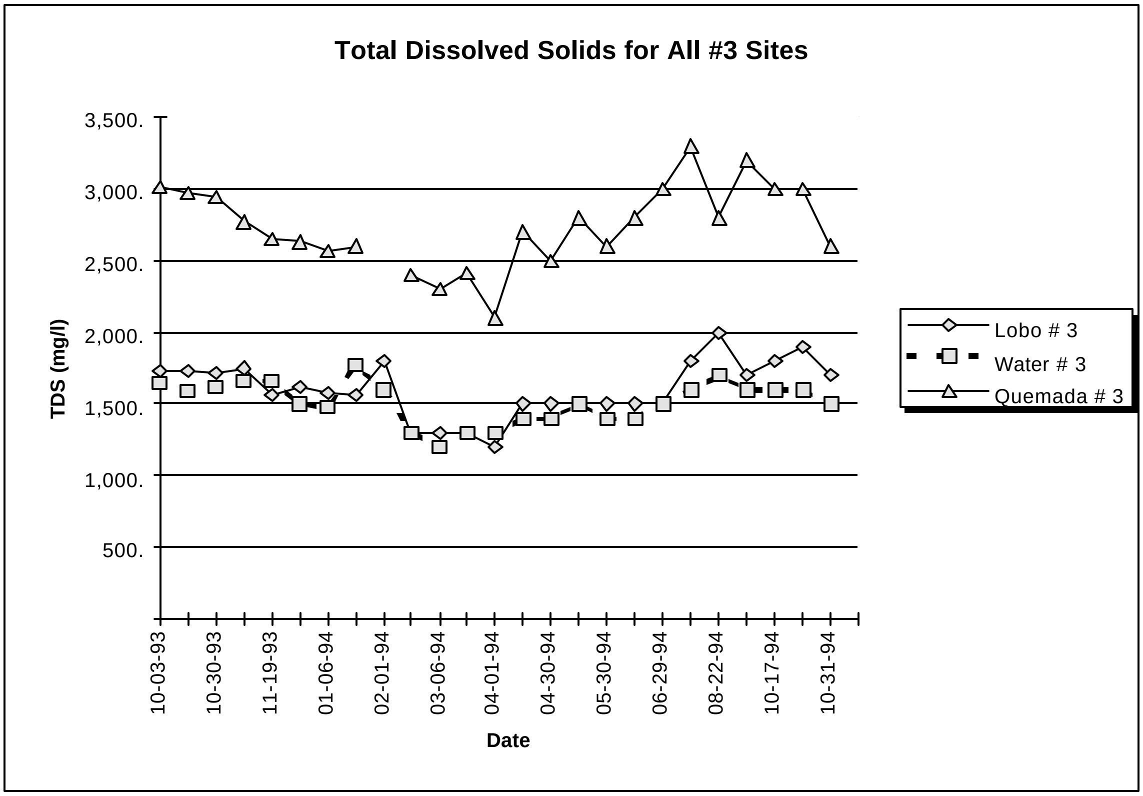


FIGURE 26 - NUTRIENTS TRENDS

8. SEDIMENTS



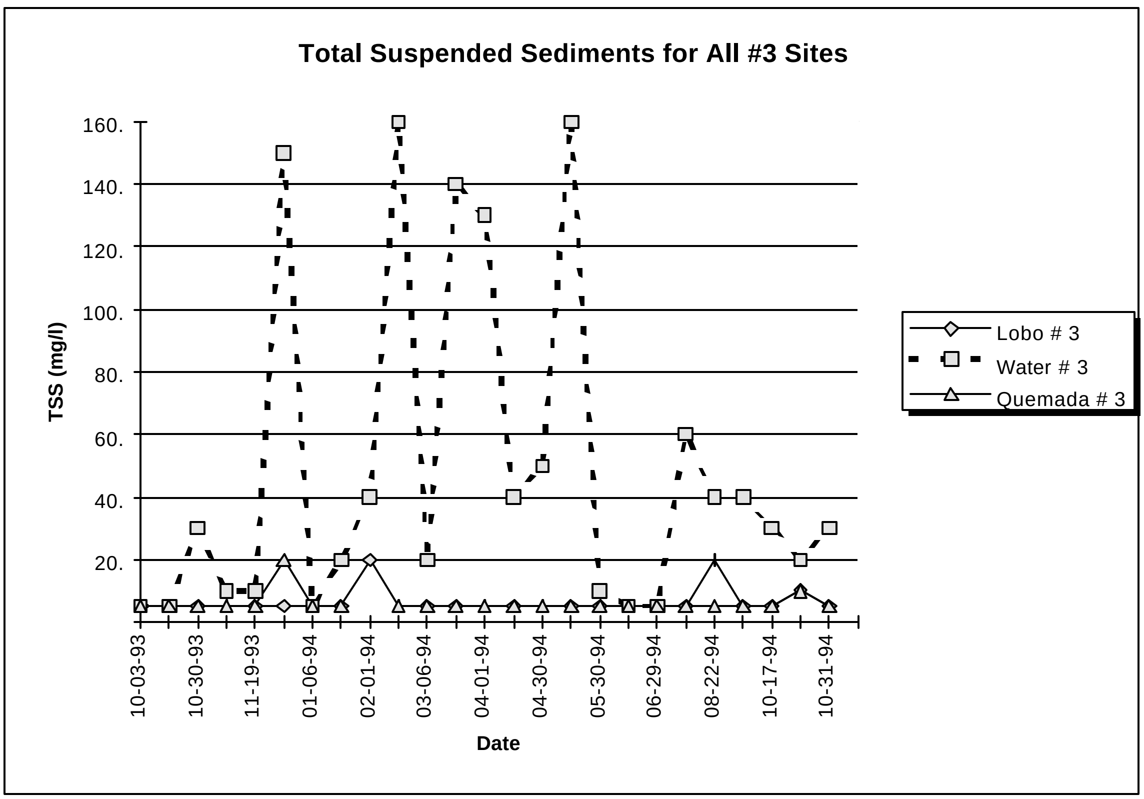
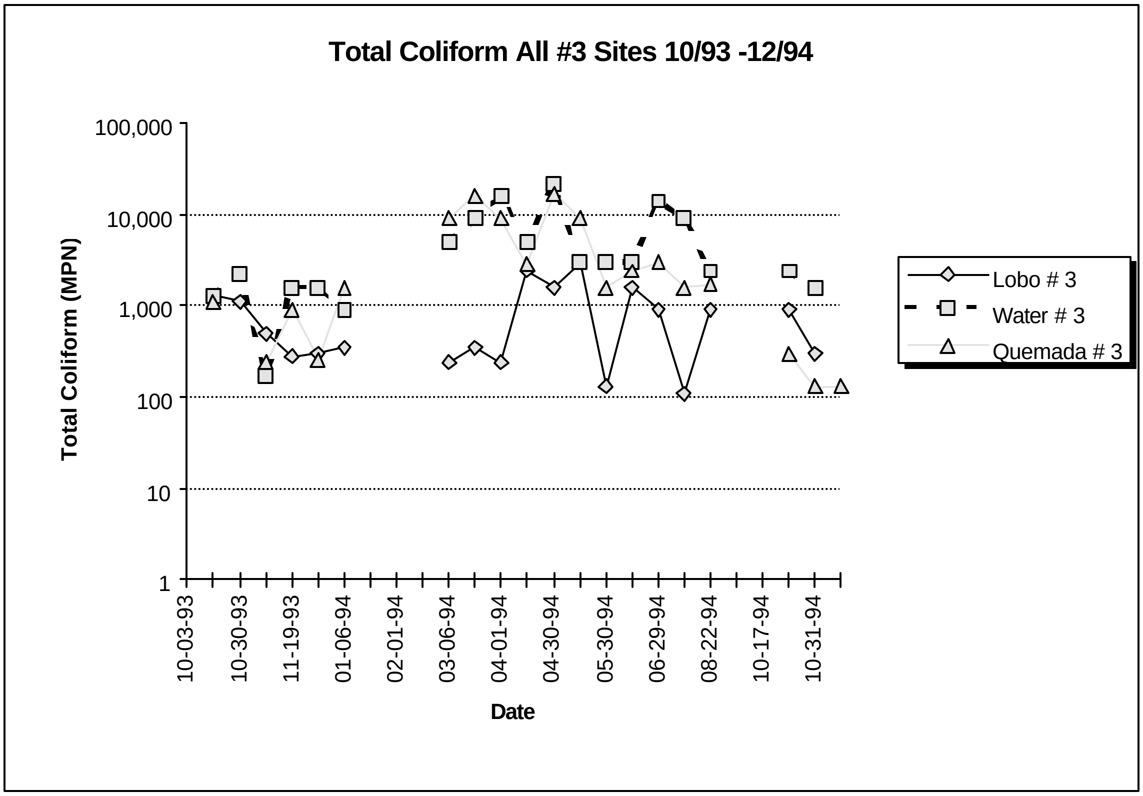


FIGURE 27 - SEDIMENTS TRENDS

9. COLIFORM



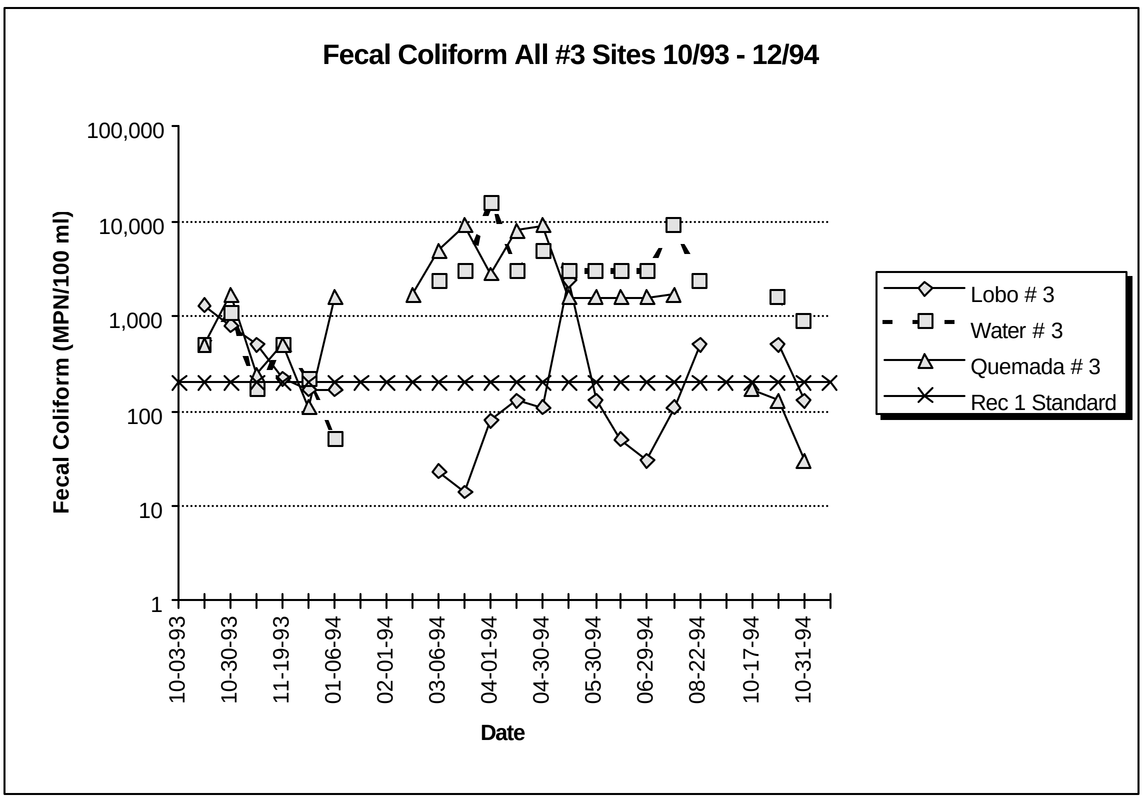


FIGURE 28 - COLIFORM TRENDS

C. CHANGES IN CHANNEL MORPHOLOGY

Channel morphology—the shape of the stream channel—is dynamic.

Figure 29 on the following page is a set of three graphs (one graph for each canyon) showing changes in depth at specific distances from the permanent marker.

It is important to remember that there is no control for the depth. Therefore, the changes in depth may be due to degradation (lowering of the elevation of the stream bed), aggregation (raising of the elevation of the stream bed), or increasing or decreasing water depth.

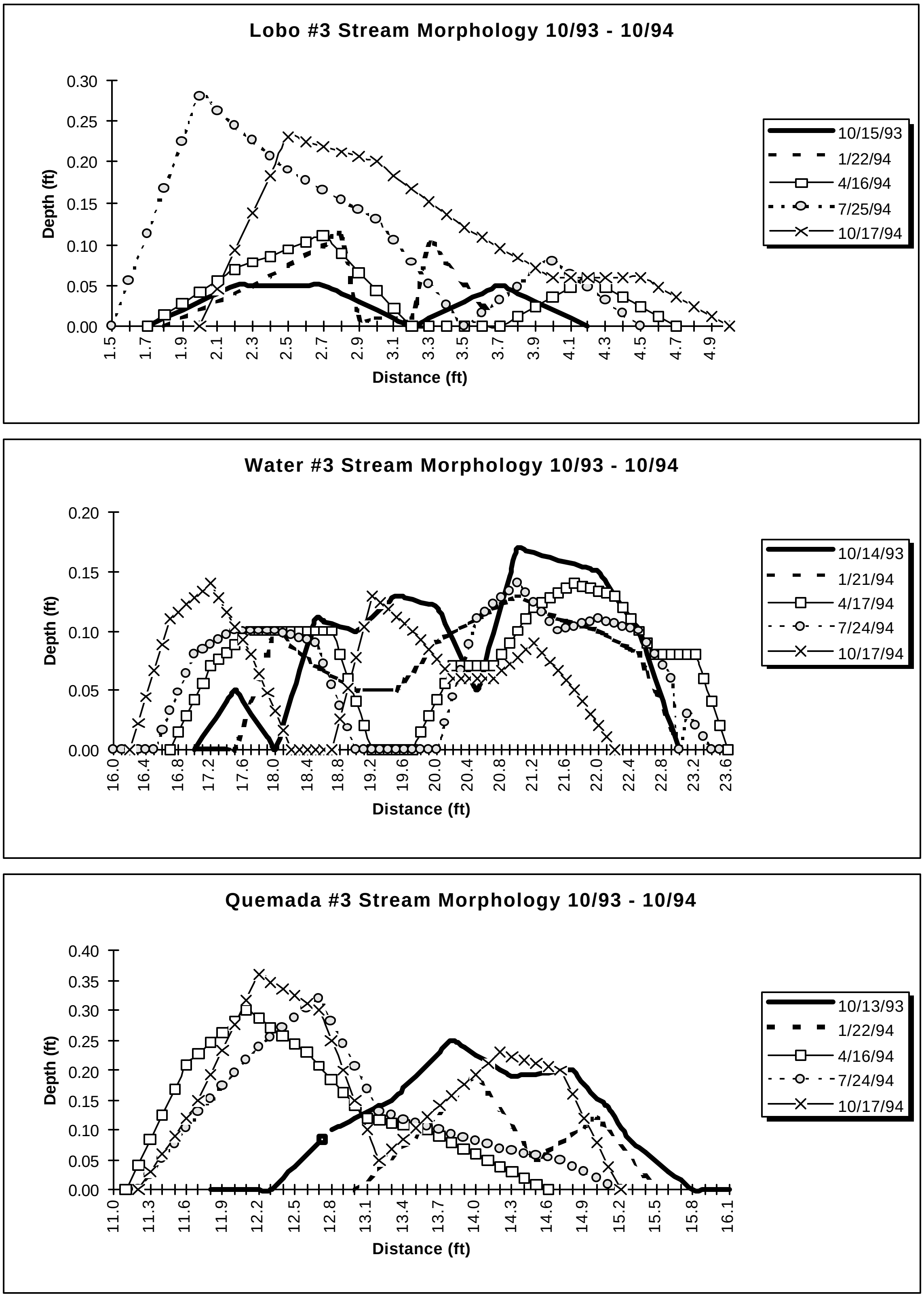


FIGURE 29 - STREAM MORPHOLOGY OF ALL THREE CANYONS

D. SAMPLE SIZE POWER ANALYSIS

One of the goals of the water quality inventory is to assess the feasibility of a long term water quality monitoring program. One important aspect of ecological monitoring is having an adequate sample size to measure the variability inherent in the system. Ideally, a monitoring program will have sufficient samples to measure the system precisely and accurately.

An analysis of the sample size required to measure water quality was conducted such that 80% of the measurements are within 20% of the mean. The analysis uses the following formula:

$$\mathbf{n} = \frac{(t^2)\,(CV)^2}{(D)^2}$$

Where:

n =	sample size
t =	value from Student's t-table at desired level of probability and given sample size
CV =	Coefficient of Variation of sample
D =	1/2 width of Desired confidence interval (%)

(Zar, 1984)

The analysis used values obtained from the water quality inventory.

Table 14 on the next page shows the results of the analysis for each site for all parameters measured during the inventory.

TABLE 14 - NUMBER OF SAMPLES REQUIRED

PARAMETER	LOBO 3	LOBO 4	WATER 2	WATER 3	WATER 4	CLAPP SPRINGS	QUEMADA 2	QUEMADA 3	QUEMADA 4
Discharge	138	52	25	19	22	N/A	28	28	45
Water Temperature	1	2	3	3	4	2	4	3	2
pH	1	1	1	1	1	1	1	1	1
Conductivity	2	1	3	1	1	1	2	1	1
Dissolved Oxygen	1	1	1	1	1	1	1	4	1
Turbidity	114	89	113	74	137	56	127	235	72
Total Nitrogen	19	N/A	N/A	68	N/A	N/A	N/A	6	N/A
Total Phosphorus	46	N/A	N/A	75	N/A	N/A	N/A	70	N/A
Total Dissolved Solids	1	N/A	N/A	1	N/A	N/A	N/A	1	N/A
Total Suspended Sediments	19	N/A	N/A	52	N/A	N/A	N/A	13	N/A
Total Coliform	39	N/A	N/A	54	N/A	N/A	N/A	68	N/A
Fecal Coliform	101	N/A	N/A	68	N/A	N/A	N/A	59	N/A

N/A = NOT APPLICABLE (NOT MEASURED AT THIS SITE)

E. COMPARISON BETWEEN SITES WITHIN STREAMS

Since most of the data is not normally distributed, non-parametric statistical analysis is required. Kruskal-Wallis non-parametric analysis of variance uses ranks to assess if differences in a given variable between multiple sites within a given stream are significantly different (Zar, 1984). Since Lobo Canyon has only two sites for comparison, the non-parametric Mann-Whitney U test is used. Significance value (***p***) is set at 0.20.

Table 15, Table 16, and Table 17 on the next two pages show the comparisons between sites within streams.

TABLE 15- DATA COMPARISON BETWEEN STREAMS: LOBO CANYON

DATA	SITE	N	RANK SUM	MWU STATISTIC*	*P*
Discharge (cfs)	**Lobo #3**	25	466	141	0.001
	Lobo #4	25	809		
Water Temperature(C)	**Lobo #3**	26	718	367	0.429
	Lobo #4	25	608		
Conductivity (mS/cm)	**Lobo #3**	26	636.5	285.5	0.457
	Lobo #4	25	689.5		
Turbidity (NTU)	**Lobo #3**	24	474	174	0.016
	Lobo #4	24	702		

* Mann-Whitney U Statistic

TABLE 16 - DATA COMPARISON BETWEEN SITES: WATER CANYON

DATA	SITE	N	RANK SUM	KW STATISTIC*	*P*
Discharge (cfs)	**Water #2**	15	180	24.454	0.000
	Water #3	26	1006.5		
	Water #4	25	1024.5		
Water Temperature (C)	**Water #2**	15	451.5	3.048	0.218
	Water #3	26	1004.0		
	Water #4	25	755.5		
Conductivity (mS/cm)	**Water #2**	15	697.5	10.101	0.006
	Water #3	26	697		
	Water #4	25	816.5		
Dissolved Oxygen (mg/l)	**Water #2**	15	452	3.328	0.189
	Water #3	26	783.5		
	Water #4	25	975.5		
Turbidity (NTU)	**Water #2**	15	422	3.394	0.174
	Water #3	25	947		
	Water #4	26	711		

* Kruskal-Wallis Statistic

TABLE 17 - DATA COMPARISON BETWEEN SITES: QUEMADA CANYON

DATA	SITE	N	RANK SUM	KW STATISTIC*	*P*
Discharge (cfs)	**Quemada #2**	22	614	5.145	0.076
	Quemada #3	25	977		
	Quemada #4	17	489		
Water Temperature (C)	**Clapp Springs**	21	705	13.635	0.003
	Quemada #2	22	787		
	Quemada #3	25	1136.5		
	Quemada #4	17	1026.5		
Conductivity (mS/cm)	**Clapp Springs**	21	231	60.119	0.000
	Quemada #2	22	847		
	Quemada #3	25	1462		
	Quemada #4	17	1115		
Dissolved Oxygen (mg/l)	**Clapp Springs**	21	383	30.779	0.000
	Quemada #2	22	1036		
	Quemada #3	25	1436.5		
	Quemada #4	17	799.5		
Turbidity (NTU)	**Clapp Springs**	20	594.5	18.340	0.000
	Quemada #2	21	1172		
	Quemada #3	24	781		
	Quemada #4	17	855.5		

* Kruskal-Wallis Statistic

F. STORM-EVENT MONITORING

Staff encountered several problems when monitoring the streams during storm events:

- Staff had difficulty accurately predicting which storms were worthy of monitoring. On several occasions staff discussed weather reports and then choose storms that did not have enough rainfall to affect the island's streams. Other storms were not chosen which subsequently precipitated heavily.
- Staff had difficulty maintaining safety during storm event monitoring — a far more serious problem. During major winter storms (rain in excess of two inches in 24 hours), stream waters rose so high that staff could not safely stand within the water column. Since staff always erred on the side of safety, no significant winter storms were successfully monitored.
- Staff also had difficulty obtaining transportation to the island on short notice and maintaining morale during the storm. Tents may be waterproof, but they are certainly not windproof.

The graph below shows the results for the first and only successfully monitored storm. This storm —

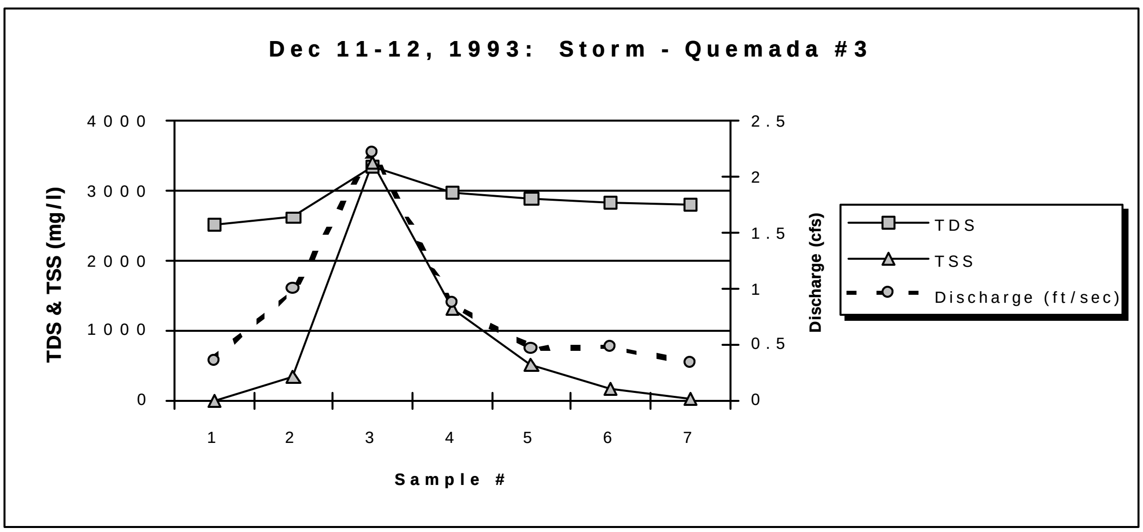


FIGURE 30 - STORM - QUEMADA #3

which precipitated 0.76 inches of rain — was monitored at Quemada #3.

G. PROTOCOL DESIGN

Initial protocol design was based upon techniques used by the US Forest Service at the Lake Tahoe Management Basin. The Channel Islands National Park range conservationist was detailed to Lake Tahoe where she worked with staff there to learn the specific techniques used to establish monitoring sites, measure discharge, and analyze water samples within the laboratory. Additional insight into the protocol design was provided by staff at the Central Coast Regional Water Quality Control Board and Water Resources Division (NPS).

The protocol used for the water quality inventory of Santa Rosa Island is shown in Appendix B. This protocol has been modified slightly during the course of the inventory. For instance, it was decided that all stations in one stream are to be monitored on the same day. Monitoring should be completed before the onset of a rain storm. If it cannot, then monitoring should be delayed until after the storm has passed. A final protocol design will be submitted for peer review shortly.

V. DISCUSSION

A. ANALYSIS OF DATA

There are several interesting aspects of the data worthy of discussion. The first concerns the quantity of water on the island. Base flows on Santa Rosa are very low, averaging 0.025 cfs for Lobo Canyon to 0.198 cfs for Water Canyon. It is estimated that greater than 99% of the water which flows down the streams on Santa Rosa Island occurs during major storm events. Streams that are barely two inches deep during base flows can be as much as six feet deep during a major winter Pacific storm. Examination of the time series data for discharge shows that flows increased during the peak rainfall periods in the late winter and early spring.

Data from Lobo Canyon indicates that there are multiple inputs of water in this drainage. The fact that Lobo #4 had higher flow than Lobo #3 suggests that water inputs between the two sites are greater than the loss of water due to evaporation and plant uptake. The substantial riparian cover probably inhibits loss due to evaporation but increases losses due to water uptake by riparian plants. By the end of summer there were large sections of the stream between Lobo #3 and Lobo #4 which were completely dry, yet Lobo #4 flowed steadily throughout the study. This is another line of evidence on the role of multiple inputs of water into the stream.

Data from Water Canyon also suggests that there are multiple inputs of water. This must especially be true for the stream segments between Water #2 and Water #3. Initial surveys of the stream showed that there were a number of distinct seeps and springs between the two sites. The relatively minor difference between Water #3 and Water #4 is most likely due to a tributary flowing from the chaparral areas on the north side of the watershed.

The picture for the flow in Quemada Canyon is not nearly as clear. The origin of the water in Quemada Canyon is the diversion of Clapp Springs located in the adjacent San Augustine Canyon. Unfortunately, flows were not measured at Clapp Springs so it not known how much of the water in Quemada Canyon originates from Clapp Springs. Another complicating factor is the flow from Box Canyon. Although Box Canyon is part of the Quemada watershed, it was not monitored. Quemada #3, which has the highest flow, is located below the confluence of Quemada Canyon and Box Canyon. The high levels of discharge measured at Quemada #3 are no doubt influenced by flow from Box Canyon. It is interesting to note that flow was lower at Quemada #4 than at Quemada #3 suggesting that water losses exceeded water inputs in that stretch.

The temperature of the waters of Santa Rosa Island is another fascinating story. For the most part, the water in the streams monitored was unusually warm. This is most likely a reflection of the lack of adequate riparian vegetation on the island which shades and cools stream waters. Lower Lobo Canyon is one area that has a healthy riparian community. It is interesting to note that the mean water temperature at Lobo #4 is lower than the mean water temperature at Lobo #3. In general, sites which have some kind of shading — either through riparian vegetation (like Lobo #3 and Lobo #4) or steep,-cut banks (like Water #2, Water #4, and Quemada #2) had lower mean water temperatures than did other less shaded sites. This was most noticeable in Quemada Canyon. It is worthy to note that during the hot summer months, sampling usually started at Quemada #4 early in the morning and upstream sites were measured sites later in the day. Despite the early morning monitoring schedule, Quemada #4 had the hottest water of all monitored sites on the island.

Another prominent aspect of the data is the high levels of pH, conductivity, salinity, and total dissolved solids in Quemada Canyon. Examination of the data from Clapp Springs (an important source of water for the drainage) shows that the water flowing from the spring has much lower values than sites downstream. Where are all of these ions coming from? One hypothesis is that as the water in the stream flows down through Quemada Canyon, it picks up particles from the soil which dissolve into the water and become ions. These ions are easily detected as increased levels of pH, conductivity, salinity and dissolved solids. It is interesting to note that in and around the mouth of Quemada Canyon (Old Ranch Canyon) contains the only salt water marsh found in the Channel Islands. Vegetation in the lower reaches of Quemada Canyon include such salt-tolerant species as saltgrass (*Distichlis spicata*), pickleweed *(Salicornia virginica*), and Frankenia (*Frankenia salina*).

A final item for discussion of the data is the high levels of total and fecal coliform. Coliform levels on Santa Rosa are very high. Geometric means of coliform in Water Canyon and Quemada Canyon indicate that coliform levels are six or seven times the maximum standard (200 MPN) for the beneficial uses set for the island. These elevated levels most likely reflect the unlimited access of cattle to these streams. Lobo Canyon appears to be the exception. This may be due to the sheer cliff walls found within the drainage. The steep cliffs limit the accessibility of cattle to the stream.

B. ANALYSIS OF CURRENT METHODOLOGY

One of the two objectives of the water quality inventory is to develop a water quality monitoring program at Channel Islands National Park. Generally, inventories tend to be more intensive than routine monitoring. The question arises if a water quality monitoring program should monitor more or less sites per stream, more or less streams, and with a greater or lesser monitoring frequency. Another related issue is whether the appropriate parameters are being measured. A water quality protocol is being developed by Park staff. This protocol will be reviewed by water quality experts. Some of the issues that need to be examined in the development of the protocol are discussed below.

Examination of the results of the non-parametric analysis of variance show that most parameters were significantly different between sites within a stream. This indicates that each site is unique in a number of measures of water quality. Although each site is important, a number of sites (especially in the upper reaches of the watersheds) did not have sufficient flow to monitor. Other sites flowed only during the height of the rainy season. Should these sites be excluded from the monitoring program?

Three streams were monitored as part of the inventory. The streams were chosen because of their proximity to Beecher's Bay, the Park Service hub of activity on the island. All of the streams can be reached by foot if necessary. Other streams on the island are inaccessible during the rainy season. For instance, it has been reported that after the torrential rains of January, 1995, there is a six-foot deep gully where the Smith Highway crosses Verde Canyon (Brown, *pers. com*.). Increasing the number of drainages will likely lead to increased monitoring costs (due to helicopter flights) and/or periods of time when data will not be obtained (usually in the winter).

A number of parameters were monitored during the inventory. An examination of the information obtain from different parameters is worthwhile. Total Nitrogen and total Phosphorus were rarely detected with any confidence. Yet, from the large amounts of algae (*Cladophora* spp.) that grow each year in the streams, there are obviously plenty of nutrients available. Alternative methods for assessing nutrient loads in the streams need to be developed. Dissolved Oxygen is another parameter that has yielded interesting results. Consistently, the DO levels have been very high indicating that the streams are super-saturated with Oxygen. However, DO levels are susceptible to diurnal changes with the lowest values being found pre-dawn (Kolb, *pers. com*.). Measuring the DO and temperature levels at one site over a 24-hour period may help interpret the high values measured during the inventory.

Finally, the monitoring frequency during the inventory was intense. Park staff strove to monitor all flowing sites every two weeks over the course of the inventory. This was logistically very difficult to maintain. The analysis of the sample size shows that there is little value in maintaining this high monitoring frequency. Parameters which showed little variation through the study (like water temperature and pH) need very few samples to achieve the precision and accuracy frequently used by land management agencies. But more variable parameters need so many more samples to adequately characterize the water quality that it is logistically unfeasible to accomplish. It has been suggested that the need for such a large sample size (for such parameters as discharge and turbidity) is due to lack of precision —repeatability of measurements — and not with accuracy (Rosenlieb, *pers. com.*). In other words, the water quality inventory has adequately measured the mean values of the parameters but has not fully characterized the range of values possible.

It appears that the most rigorous frequency possible should be attempted. This goal needs to be weighed against logistical and financial realities of conducting water quality monitoring in such a remote setting. Without technical staff to conduct the monitoring and a budget to fund transportation and lab analysis, maintaining a rigorous monitoring frequency is not feasible in the long term. See Appendix D for a complete discussion of program options and their costs.

C. RECOMMENDATIONS

A number of recommendations for the water quality monitoring program can be made at this time. The following is a list of recommendations for the continuation of the water quality monitoring on Santa Rosa Island.

- Continue with the monitoring of water quality on a regular basis.
- Exclude Lobo #1, Lobo #2, Water #1, and Quemada #1 from future monitoring.
- Monitor remaining sites as long as flow is sufficient.
- Expand the monitoring program to include at least three other streams — preferably one more stream on the north side of the island, one on the south side of the island, and one on the west side of the island.
- Reduce monitoring frequency to once a month. Stagger monitoring such that three streams are monitored during one two-week period and the other three streams are monitored during the other two-week period.
- Discontinue laboratory analysis of total Nitrogen, total Phosphorus, total dissolved solids, and total suspended solids.
- Continue laboratory analysis of total and fecal coliform.
- Monitor dissolved Oxygen frequently at regular intervals over a 24-hour period and quarterly at one station on each stream.
- Purchase and install an automated sampler to monitor storm events for changes in discharge and total suspended solids.
- Install stage gauges with peak flow measurement capabilities to monitor storm events.

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VI. APPENDIX A — CALIBRATION PROTOCOL FOR HORIBA U-10

The Horiba U-10 water quality checker must be calibrated prior to use on the island. There are two kinds of calibrations — *automatic* and *manual*:

1. Automatic calibration is conducted prior to manual calibration. It calibrates all sensors to pre-established ranges and is the only calibration for the pH span and both the zero and span calibration for conductivity. Automatic calibration should also be conducted whenever an error message occurs and when a monitoring event extends beyond three days.
2. Manual calibration is conducted on the mainland prior to departure for the island. This process takes approximately 90 minutes.

In the past, problems have arisen with the turbidity sensor. When turbidity readings are low (<100 NTU), the wide range of values for which the automatic calibration is set can lead to error messages. For this reason, it is important to conduct the span calibration for turbidity after automatically calibrating the Horiba U-10.

EQUIPMENT CARE

Follow these maintenance procedures in order to assure proper equipment integrity:

1. Wash the turbidity sensor. Periodically, carefully wash out the turbidity sensor with distilled water and a test tube brush. Do not use abrasives or cleansers. Be careful not to scratch the sensor cylinder.
2. Clean the conductivity sensor. Periodically, remove the conductivity sensor guard and carefully clean the sensor with a soft brush. Replace the conductivity sensor guard once finished.
3. Recharge the reference sensor. Replace the reference sensor solution every other month. The reference solution is stored with the Horiba U-10:
   A. Remove the rubber cap from the reference sensor and wash out the old solution with distilled water.
   B. Fill the reference sensor completely with new reference solution. Make sure there are no air bubbles.
   C. Replace rubber cap and carefully wash off all excess reference solutions with distilled water.
4. Store the U-10 carefully. For brief storage periods (one week or less), fill the calibration beaker with distilled water and fit the probe into the beaker. For longer storage periods conduct the following:
   A. Keep the pH sensor moist. Fill the small rubber cap with distilled water and place over the pH sensor.

B. Ensure the reference sensor solution does not leak from the reference sensor. Place vinyl tape around the O-ring portion of the sensor cap.

C. Remove battery from the main unit.

AUTOMATIC CALIBRATION

Automatic calibration is conducted prior to the manual calibration. Automatic calibration is also used to calibrate conductivity. Conduct the **pH Span Calibration** procedure just before conducting the automatic calibration. **Do not remove the pH 4 standard solution <u>or</u> the U-10 probe from the U-10 calibration beaker.**

PH SPAN CALIBRATION

Conduct this procedure just before conducting the automatic calibration. It needs to be conducted only once during a tour.

1. Wash the probe 2-3 times using distilled water.
2. Fill the **U-10 calibration beaker** to the **fill line** with the **pH 4 standard solution.**
3. Place the calibration beaker in the sink. Place the probe into the calibration beaker. Turn the power **ON**.
4. Use the **SELECT key** to move the upper cursor to **TEMP**. Record the standard solution's temperature.
5. Press the **MODE key three times** to move the lower cursor to **SPAN**.
6. Use the **SELECT key** to move the upper cursor to **pH**.
7. When the reading has stabilized, use the **UP/DOWN keys** to select the temperature-corrected value of the pH 4 standard solution. Refer to Table 20 for the temperature-corrected pH values of the standard solutions.
8. Press the **ENT key** to set the span calibration for the pH.

AUTOMATIC CALIBRATION

1. After completing the **pH span calibration**, move the lower cursor to **AUTO** by pressing the **MODE key four times**.
2. With the lower cursor on **AUTO**, press the **ENT key**. The readout will show **CAL**. When the auto-calibration is complete, the readout will briefly show **END** and then will switch to the **MEAS** mode.

MANUAL CALIBRATION

Manual calibration of the U-10 must be completed prior to departure for the island. The time involved to calibrate it varies considerably. Most of the calibration procedures require the U-10 to stabilize readings. This can happen rapidly or it can take a long time. It is important to allow plenty of time to calibrate the equipment. Calibrating the U-10 the day before travel is usually best.

There are two kinds of manual calibrations — *zero* and *span*:

1. Zero calibration sets the zero standard for the parameter to be measured.
2. Span calibration sets a predetermined standard for each of the parameters.

Turbidity, dissolved Oxygen, and the zero calibration part of pH are calibrated manually. The span calibration of pH, conductivity, salinity, and temperature are adjusted during the automatic calibration procedure.

TABLE 18- EQUIPMENT NEEDED FOR MANUAL CALIBRATION OF HORIBA U-10

ITEM NEEDED	PURPOSE
Distilled water (approximately one gallon).	Rinse equipment
1 liter squirt bottle of distilled water	Rinse equipment
500 ml beaker	Mix solutions and place probe into
500 ml graduated cylinder	Exactly measure distilled water
50 ml pipette with pipette bulb	Exactly measure Formazin solution
Accurate electronic scale	Exactly weigh sodium sulfite
4000 NTU Formazin solution	Calibrate turbidity
Sodium sulfite	Calibrate Dissolved Oxygen
pH 7 standard solution	Calibrate pH
Stirring stick -	Mix solutions

TURBIDITY CALIBRATION

Turbidity is calibrated using distilled water and a solution of Formazin.

ZERO CALIBRATION

1. Wash the probe thoroughly 2-3 times using distilled water. Shake off excess water droplets after cleaning.
2. Fill the **500 ml beaker** with roughly **350 ml** of distilled water.
3. Put the beaker into the sink. Place the probe into the beaker.
4. Turn the U-10 **ON**, press the **MODE key twice** to move the lower cursor to **ZERO**.

5. Use the **SELECT key** to move the upper cursor to **TURB**.
6. After the readout has stabilized (10-30 seconds), set the U-10 to **0.0** using the **UP/DOWN keys**.
7. Press the **ENT key** to complete the procedure.

SPAN CALIBRATION

1. Rinse U-10 probe and 50 ml pipette with distilled water. Place pipette bulb on end of pipette with "S" valve on pipette. Shake 4000 NTU Formazin solution thoroughly.
   A. Squeeze bulb and "A" valve simultaneously. Insert pipette into Formazin solution. Squeeze "S" valve to draw up Formazin solution. Repeat process until the meniscus is at 50 ml.
   B. Move pipette to **500 ml graduated beaker**. Squeeze "E" valve to release solution.
2. Add distilled water to Formazin solution up to the **250 ml** line. This solution is now an 800 NTU solution. Transfer the 800 NTU solution into a rinsed plastic bottle and label and date.
3. Rinse pipette with distilled water. Rinse bulb if it was contaminated with the Formazin solution. Rinse the 500 ml graduated beaker with distilled water.
4. Use pipette again to draw **50 ml** of the **800 NTU** solution using the same technique as in **Step 1-A** above.
5. Transfer the 800 NTU solution from the pipette into the **500 ml graduated beaker** using the same techniques in **Step 1-B** above.
6. Add distilled water to the Formazin solution to the **200 ml line**. This is now the **200 NTU Formazin solution**.
7. Label and date the 800 NTU Formazin solution. Store the bottle in the specified refrigerator.
8. Transfer solution to **500 ml beaker**. Rinse 50 ml pipette and 500 ml graduated beaker with distilled water. Rinse pipette bulb if became contaminated with Formazin solution.
9. Stir the **200 NTU Formazin solution** thoroughly and place the probe into the solution.
10. Turn U-10 power **ON**. Press the **MODE key three times** to move the lower cursor to **SPAN**.
11. Use the **SELECT key** to move the upper cursor to **TURB**.
12. After the readout has stabilized (90 seconds or more), set the readout to **200** using the **UP/DOWN keys**. NOTE: The readout for turbidity is quite variable. Try gently swishing the Formazin solution with the probe inside the beaker.
13. Press the **ENT key** to set the span calibration.
14. Run tap water into the sink and pour the Formazin solution down the drain. The

sewage district gave permission to pour the calibration chemicals into the sewage system.

DISSOLVED OXYGEN CALIBRATION

Dissolved Oxygen is calibrated using distilled water and a solution of sodium sulfite.

ZERO CALIBRATION

1. Measure **exactly 25.00 grams** of **sodium sulfite** using the electronic scale. Measure **500 ml** of distilled water using the graduated beaker. Pour the distilled water into the 500 ml beaker. Add the sodium sulfite to the distilled water. Stir the solution until the sodium sulfite has **completely** dissolved. This solution is the **zero calibration solution**.
2. Wash the probe 2-3 times with distilled water, shake off excess water, and place it into the 500 ml beaker with the zero standard solution.
3. Turn the power **ON**. Press the **MODE key twice** to move the cursor to **ZERO**.
4. Use the **SELECT key** to move the upper cursor to **DO**.
5. After the readings have stabilized (2-5 minutes), set the readout to **0.0** using the **UP/DOWN keys**.
6. Press the **ENT key** to set the zero calibration.
7. Rinse the probe with distilled water. Pour the sodium sulfite solution down the drain.

SPAN CALIBRATION

1. Rinse Horiba U-10 in distilled water. Shake off excess water and allow to dry. Make sure the temperature and DO sensors are **COMPLETELY DRY**.
2. Turn the power **ON**. Use the **SELECT key** to move the upper cursor to **TEMP**. Record the temperature of the air.
3. Press the **MODE key three times** to move the lower cursor to **SPAN**.
4. Use the **SELECT key** to move the upper cursor to **DO**.
5. After the reading has stabilized (60-90 seconds), set the readout values to the appropriate DO value for the air's temperature. Refer to Table 19 on the next page for these values. If the temperature is between two values, choose the closest value.
6. Press the **ENT key** to set the span calibration for DO.

TABLE 19 - AMOUNTS OF SATURATED DISSOLVED OXYGEN IN WATER AT VARIOUS TEMPERATURES

TEMPERATURE (C)	DISSOLVED OXYGEN
15	9.76
16	9.56
17	9.37
18	9.18
19	9.01
20	8.84
21	8.68
22	8.53
23	8.39
24	8.25
25	8.11
26	7.99
27	7.87
28	7.75
29	7.64
30	7.53
31	7.42
32	7.32
33	7.22
34	7.13
35	7.04

pH CALIBRATION

pH calibration uses two different types of standard solutions: pH 4 (or span calibration) and pH 7 (or zero calibration).

ZERO CALIBRATION

1. Wash the probe 2-3 times with distilled water and shake off excess water.

2. Fill the **U-10 calibration beaker** (the beaker the U-10 is stored in) just above the **fill line** with **pH 7 standard solution**.
3. Place the probe into the calibration beaker and turn the power **ON**.
4. Use the **SELECT key** to move the upper cursor to **TEMP**. Record the standard solution's temperature.
5. Press the **MODE key twice** to move the lower cursor to **ZERO**.
6. Use the **SELECT key** to move the upper cursor to **pH**.
7. When the reading has stabilized, use the **UP/DOWN keys** to select the temperature corrected values of the pH 7 standard solution. Refer to Table 20 below for the temperature-corrected pH values of the standard solutions.
8. Press the **ENT key** to set the zero calibration for pH.

TABLE 20 - TEMPERATURE-CORRECTED PH VALUES OF STANDARD SOLUTIONS

TEMP (C/F)	PH 4	PH 7
0/32	4.01	6.98
5/41	4.01	6.95
10/50	4.00	6.92
15/59	4.00	6.90
20/68	4.00	6.88
25/77	4.01	6.86
30/86	4.01	6.85
35/95	4.02	6.84
40/104	4.03	6.84

CHEMICAL SUPPLIES

Calibration chemicals are usually ordered through the HACH Co at 1-800-227-4224. Table 21 below lists the required calibration chemicals and their shelf lives.

TABLE 21 - SHELF LIFE OF CALIBRATION CHEMICALS

PRODUCT	SHELF LIFE (MONTHS)
Formazin 8000 NTU Solution	6
Sodium Sulfite Anhydrous	12
pH 4 Standard Solution	12
pH 7 Standard Solution	12

VII. APPENDIX B — MONITORING PROTOCOL FOR ROUTINE MONITORING

SAMPLING EQUIPMENT

All water quality sampling equipment — except the Horiba U-10 Water Checker (U-10) — is stored in the Resource Management (RM) connex box on Santa Rosa Island (SRI). The U-10 is stored in the RM Annex. It must be calibrated both manually and automatically every other week following the *Manual and Automatic Calibration Protocols* (see attached documents). Always maintain emergency battery replacements on SRI for the U-10 and Marsh-McBirney Flow Mate 2000 (Flow Mate).

EQUIPMENT NEEDED IN THE FIELD:

1. Horiba U-10 Water Checker (U-10)
2. Marsh-McBirney Flow Mate 2000 (Flow Mate)
3. Top Setting Rod (TSR)
4. Clipboard with supplies (dataforms, site map, pencil, and thermometer)
5. Measuring tape (in tenths of a foot)
6. Anchoring stake
7. Sampling bottles
8. Cooler with ice
9. Extra batteries (9-volt and D-cell)
10. Equipment manuals
11. Tape recorder

SITE DESCRIPTIONS

Use the provided site descriptions and maps to locate established sampling sites. Submerged rebar stakes, located on stream banks, identify each individual sampling site in the field

LOBO CANYON

Lobo #1 is located at the confluence of three tributaries at the foot of Black Mountain. The best approach is to take the Smith Highway to the North Pasture. Note a two-rut road on the east side of Lobo Canyon heading up to Black Mountain. Park at the beginning of this road and walk up the road. The road will cross just downstream from the site. Rebar stake is on the right bank.

Lobo #2 is located approximately 100 meters upstream from where the stream crosses the Smith Highway. The best approach is to take the Smith Highway to Lobo Canyon. Park near the picnic benches. Walk upstream. The sight is located just downstream from the first significant tributary flowing from the west-southwest. Rebar stake is on the left bank.

Lobo #3 is located 15 meters downstream from the first oak grove below the Smith Hwy (approximately 25 meters upstream from the cattle exclosure). Rebar stake is on the left bank.

Lobo #4 is located within the cattle exclusion area roughly 500 feet upstream from the ocean side gate. The site is also a trail crossing. Rebar stake is on the right bank. A large, partially-buried rock faces it on the opposite bank.

WATER CANYON

Water #1 is located approximately 1/2 mile upstream of Army Camp. The best way to approach this site is to take the Main Road to Army Camp and park. Walk down to Army Camp and take the saddle south of the star. This will lead to an old trail heading upstream. Go past the filled-in dam. Water #1 is located approximately 25 meters above the dam. Rebar stake is on the right bank.

Water #2 is located roughly 1/2 mile downstream from Army Camp. The best approach is to take the Main Road to the Army Camp Road and park. Walk down to Army Camp and drop down into the drainage via the old rusted vehicle (east side of Army Camp). Walk downstream approximately two bends. The site is located just below the second tributary from the north immediately upstream from a five-foot tall waterfall. Rebar stake is on the right bank.

Water #3 is located next to the corral in the lower portion of Water Canyon. The best approach is to take the South Road west of the Torrey Pine Road. The corral will be visible on the right (west). After driving down the side of the small ridge, take the first right road. Drive carefully down to the corral and park. Walk approximately 20 meters upstream and look for a cattle trail dropping down to the stream. Take the cattle trail (a small gully) down to the stream. Rebar stake on the right bank less than 10 meters downstream from the cattle trail.

Water #4 is located below the campground.. The best approach is to take the campground road (also known as *the high road*) to the campground trail. Instead of taking the campground trail up, drop down the steep trail to the stream. Rebar stake is on the left bank under a toyon tree less than 10 meters from where that trail meets the stream. There is currently a large 10-foot tall boulder located less than 10 meters downstream from the site.

QUEMADA CANYON

Quemada #1 is located approximately 50 meters below Clapp Springs water tank. Clapp Springs water tank is located approximately ¼ mile from the South Road on the Sierra Pablo Road.

Quemada #2 is located at the Las Cruces corral. The best approach is to take the South Road. Just before the south gate is another road heading down into the canyon on the left. Take this road down to the corral. Park near the salt lick and continue down the road on foot to the stream. From there, head downstream almost to the fence. Rebar stake is on the right bank.

Quemada #3 is located near the corral in Old Ranch Canyon. The best approach is to take the East Point Road to the corral in Old Ranch Canyon. Park there. Walk along the corral toward the stream and find a cattle trail angling upstream. Follow this trail. Rebar stake is on the right bank under a baccharis bush (tree) across the stream from where the trail flattens out.

Quemada #4 is located in the lower reaches of Old Ranch Canyon. The best approach is to take the East Point Road into Old Ranch Canyon. Follow the road through much of the canyon. Near the mouth of the canyon there is a small rise. Go up the rise and park. Find the cattle trail perpendicular to the road heading east toward the stream. Take this cattle trail to the stream. Rebar stake is on the right bank less than 10 meters upstream from where the cattle trail meets the stream.

SAMPLING METHOD

1. Establish a stream transect:

   A. Attach the measuring tape to the submerged rebar stake.

   B. Tautly secure the measuring tape to the bank opposite the submerged rebar stake. Use the anchoring stake or vegetation to secure the measuring tape. Make sure the measuring tape forms a line transect that is perpendicular to the flow of the stream.

2. Record the following on the DATAFORM:

   A. Station (the sampling site's name)

   B. Sampler (the sampler's initials)

   C. Recorder (the recorder's initials)

   D. Date & time

   E. Weather (a brief description of the weather; note cloud conditions and winds)

   F. Remarks (any pertinent information about the sampling site)

3. Collect grab samples. NOTE: Only collect grab samples at designated grab sampling sites (usually site #3). The total Nitrogen and total Phosphorus grab bottle is labeled H_2SO_4. The total dissolved solids (TDS) and total suspended solids (TSS) bottle is not labeled. Be certain to always keep samples cool and closed tightly.

   A. Label sample bottles.

   B. Rinse the TSS/TDS bottle and it's cap three times (be certain to not disturb the stream bottom material; empty to the side or downstream). **DO NOT** rinse the total Nitrogen and total Phosphorus bottle.

   C. Fill the sediment bottle by holding them just beneath the stream surface in a well-mixed region of the stream. NOTE: Depth-integrated samples using the DH-48 should be used when the mean water depth is over one foot.

D. Pour water into the nutrient bottle and cap.

E. Fill the sediment bottle again and cap.

4. Establish stream transect increments:

A. Determine the right and left edge of water (REW & LEW) along the stream transect. The right and left edge of a stream is determined facing downstream.

B. In ascending order, designate increments of 1/2 foot along the stream transect between the two edges of water.

C. Record the stream transect increments (including values for the REW and LEW) in the DIST column on the DATAFORM.

5. Measure stream velocity at each stream transect increment:

A. Connect the Flow Mate's sensor to the TSR. Press the ON button.

B. Use the TSR to measure stream depth. Measure depth at the downstream side of the TSR.

C. Use the TSR to position the Flow Mate's sensor at 0.6 of the stream's depth from the surface.

D. Measure stream velocity at this depth. Average at least three Flow Mate readings.

E. Record the increment's stream depth in the DEPTH column on the DATAFORM. Record the increment's stream velocity in the VELOCITY column.

F. Continue this process until reaching the opposite edge of water.

6. Measure air temperature using the thermometer located in the clipboard. Keep the thermometer out of the direct sunlight. Record the value on the dataform.

7. Measure stream water quality with the U-10. NOTE: During conditions of low flow, the U-10 cannot be fully submerged in the stream. In this situation, rotate the probe such that the appropriate sensors are submerged when taking readings.

A. Turn on the Horiba U-10.

B. Make measurements in the following order:

1) pH and temperature

2) Conductivity and salinity

3) Turbidity

4) Dissolved Oxygen

C. Record each of these values on the dataform.

8. Remove the stream transect.

COLIFORM SAMPLING

It is important to collect these samples on the day of departure or on a day that transportation can be arranged. Call (or have dispatch call) FGL at 659-0910 to inform them of the incoming samples.

Follow the previously discussed procedures for taking grab samples **EXCEPT**:

1. Do not rinse the bottle before handling
2. Do not contaminate the sample by touching the lip or insides of the bottle.

Be sure to keep the samples cool.

Be aware of the transportation off the island and allow ample time to obtain (at least 90 minutes) and transport coliform samples, keeping in mind the six-hour holding time. Additionally, if the Pacific Ranger (PR) is the boat taking the samples in, other transportation will be required since the PR takes a minimum of 4½ hours to travel to Ventura. Remember, it takes 20 minutes to get to FGL in Santa Paula. Money is usually set aside in the budget for such situations.

VIII. APPENDIX C — LABORATORY ANALYSIS PROTOCOL

Fruit Growers Laboratory of Santa Paula, CA was awarded the laboratory analysis contract in August, 1993. FGL conducted lab analysis of several parameters including total Nitrogen, total Phosphorus, total dissolved solids, total suspended solids, total coliform, and fecal coliform.

Water samples for total Nitrogen, total Phosphorus, total dissolved solids, and total suspended sediments were taken at the time of monitoring at all #3 sites. All samples were grab samples taken at the thalwag just below the surface of the stream. Water samples were taken prior to measurement of flow and other parameters.

- Water samples for total dissolved solids and total suspended sediments were taken using a sterilized plastic bottle provided by the lab. Sample bottles and caps were rinsed three times in native water.
- Water samples for analysis of total Nitrogen and total Phosphorus were preserved with H_2SO_4. Therefore these bottles were not rinsed prior to acquisition of the sample.
- Water from the sediment bottle was collected and transferred to the nutrient bottle.
- Water samples for analysis of total and fecal coliform were taken the day of transportation from the island to the mainland. Sampling began 1½2 hours prior to departure. Sample bottles were sealed, sterilized plastic bottles They contained a preservative so the sample bottles were not rinsed in native water prior to the grab sample being obtained. All samples were grab samples taken at the thalwag just below the surface of the stream. A minimum of 100 ml was obtained with each sample.

All samples bottles were marked with the site number, date, and time of collection using preprinted labels provided by FGL. Sample bottles were placed immediately in a cooler packed with ice and transferred to a refrigerator at the earliest convenience.

All samples were transported from the island using available park transportation. During transport, samples were placed in a cooler packed with ice. Usual park transportation was by boat, leaving little leeway for sample handling times. Occasionally, fixed-wing flights were obtained to ensure samples arrived at the laboratory in a timely manner. Upon arrival to the mainland, samples were immediately taken to FGL in Santa Paula where custody was transferred to laboratory personnel.

A *Chain-of-Custody Report* was maintained for each monitoring event. Frequently, FGL staff were notified in advance to be expecting water quality samples. Once at Fruit Growers Laboratory, samples were stored in a refrigerator until processing began.

Table 22 on the next page shows the laboratory analyses conducted at FGL for Channel Islands National Park. Data included are the method used, its EPA Registration Number, the STORET Number, the units used in measurement, the detection limit for reporting (DLR), the accuracy of the method used, and precision of the method used (FGL, 1994).

TABLE 22 - LABORATORY ANALYSES

CONSTITUENT	STORET NO.	EPA METHOD	UNITS	DLR	ACCURACY	PRECISION
Total Phosphorus	00665	365.4	mg/l	0.1	75-125	20
Total Nitrogen	00625	351.1	mg/l	1	80-120	20
Suspended Solids	00530	160.2	mg/l	10	N/A	20
Total Dissolved Solids	70300	160.1	mg/l	40	N/A	20
Total Coliform	31503	9221B	MPN/100ml	N/A	N/A	N/A
Fecal Coliform	31615	9221C	MPN/100ml	N/A	N/A	N/A

TOTAL NITROGEN

Total Nitrogen is a calculation based upon levels of nitrate, nitrite, and organic Kjeldahl Nitrogen. These attributes are analyzed through a digestive process using automated machinery. The sample is digested with a sulfuric acid solution containing potassium sulfate and mercuric sulfate which act as catalysts to convert organic Nitrogen into ammonium sulfate. The solution is then neutralized using sodium hydroxide and treated with alkaline phenol reagent and sodium hyperchlorite reagent. This treatment forms a blue color which is designated indophenol. Sodium nitropusside increases the intensity of the color when added and is sometimes used for low concentrations of Nitrogen. This method can measure values between 0.05 to 2.0 mg N/l (EPA, 1979).

TOTAL PHOSPHORUS

Total Phosphorus is analyzed through a digestive process using a block digestor. The sample is in a solution of H_2SO_4, K_2SO_4, and $HgSO_4$ for 2½ hours. It is then cooled, diluted to 25 ml, and placed in the autoanalyzer for determination. The method measures Phosphorus concentration between 0.01 and 20 ml P/l (EPA, 1979).

TOTAL DISSOLVED SOLIDS (TDS)

Total dissolved solids is measured through a process of filtration and drying. A well-mixed sample is filtered through a standard glass fiber filter. The filtrate is then evaporated and dried to a constant weight at 180º. This method measures TDS concentrations between 10 mg/l to 20,000 mg/l (EPA, 1979).

TOTAL SUSPENDED SEDIMENTS (TSS)

Total suspended sediments is measured through a process of filtration and drying. A well-mixed sample is filtered through a glass fiber filter. The residue retained on the filter is dried to a constant weight at 103º centigrade. This method measures TSS concentrations between 4 and 20,000 mg/l (EPA, 1979).

TOTAL COLIFORM

Total coliform is analyzed by the Multiple Tube Fermentation (MTF) method. There are two phases in analyzing water samples for total coliform — the *presumptive phase* and the *confirmation phase*.

Presumptive Phase: Samples are placed into five sets of test tubes, each containing a solution of Lauryl Tryptose Broth (LTB). The tube concentrations used are 10 ml, 1.0 ml, 0.1 ml, 0.01 ml, and 0.001 ml. Water samples of these amounts are added to premixed LTB solution in test tubes. The test tubes are gently agitated and then incubated at 35º centigrade for 48 hours. At 24 hours, the sets of test tubes are checked for signs of bacterial growth. Signs include visible growth of bacteria, changes in solution color, and production of gas bubbles. The samples are checked again at 48 hours. Any tubes showing signs of bacterial growth lead to a positive presumptive result. If all tubes fail to show any signs of bacterial growth, then the test is determined to be negative (APHA, 1992).

Confirmation Phase: This phase begins after the first 24 hours of incubation. All tubes showing positive signs of bacterial growth are submitted to the confirmatory phase. All positive tubes are gently agitated and then an aliquot is extracted and placed into another test tube containing a brilliant green Lactose Bile Broth. The solution is gently agitated and then incubated for another 48 hours at 35º centigrade. Formation of gas in the tubes at any point during the incubation period constitutes a positive confirmation. The number of positive tubes at each concentration is recorded and compared to a table provided from the American Public Health Association. This yields the Most Probable Number (MPN)/100 ml value used (APHA, 1992).

FECAL COLIFORM

Fecal coliform measures those coliform bacteria that originate from the intestinal tracts of warm-blooded animals (usually mammals). FGL uses the EC medium method to distinguish fecal coliform from other types of coliform. An aliquot from the presumptive phase of the total coliform test is taken and placed into test tubes containing the EC broth. The tubes are inoculated in a water bath at 44.5º for 24 hours. Gas produced with growth in the EC medium broth within 24 hours is considered a positive fecal coliform test. The number of positive tubes at each concentration is compared to a table produced by the American Public Health Association for determination of Most Probable Number (MPN)/100 ml (APHA, 1992).

QUALITY ASSURANCE/QUALITY CONTROL

The primary objective of Quality Assurance and Quality Control (QA/QC) is to ensure that all data is scientifically valid, defensible, and of a known accuracy and precision (FGL, 1994). The laboratory is organized into groups with staff responsible for different types of analysis within each group.

Quality assurance and control includes the following:

- For each type of analysis the accuracy, precision, and Detection Limits for Reporting (DLR) are known.
- Specific containers and preservatives are used to ensure that sample integrity is not lost through volatility or degradation during sample handling.
- Complete documentation of the chain of custody of samples is performed with each sample.
- Laboratory staff follow specified techniques in the analysis of water samples.
- Equipment is calibrated on a regular schedule using standards developed by the National Institute of Standards and Technology.
- FGL uses internal quality control procedures for assuring that the data generated from measurement systems meets prescribed criteria for data quality. Techniques used include analysis of *blank* samples, initial and continuing calibration verification, and the use of duplicates. The laboratory regularly submits to external system audits and belongs to a number of accrediting associations. See the Fruit Growers Laboratory *Quallity Assurance Manual* for complete descriptions of quality assurance procedures (FGL, 1994)

LITERATURE CITED

American Public Health Association, American Water Works Association, and Water Environment Federation, (1992) Standard Method, 18th Edition; American Public Health Association, Washington, DC.

Environmental Protection Agency (1979) “Methods for Chemical Analysis of Water and Waste Water”; EPA - 600/4-79-020.

Fruit Growers Laboratory (1994) “Quallity Assurance Manual”; FGL, Santa Paula, CA.

IX. APPENDIX D — COST OF PROGRAM

COST OF WATER QUALITY INVENTORY

This Water Quality Inventory program required a more intensive sampling regime than long-term monitoring because of over-sampling in terms of frequency, number of sites, and parameters. The program also bore the costs of the initial monitoring equipment investment. Because of the more intense sampling frequency, a biological technician was hired to conduct the majority of the field work. Finally, the database design, much of the data entry, and report finalization were contracted to a local firm. All of these aspects led to a greater initial cost than what would be expected for a monitoring program. These costs were defrayed with project money from the Water Resources Division — $35,000 was transferred to Channel Islands National Park over two fiscal years.

Table 23 below lists the costs of implementing the water quality inventory program with the following explanations:

- Cost of personnel includes the salary of the biological technician through the first year (although the technician left the program after seven months and was not replaced) and the technician's island travel per diem.
- Monitoring equipment includes the initial purchase of the capital equipment.
- Miscellaneous supplies include calibration equipment and supplies, field equipment, and other miscellaneous supplies.
- Transportation costs include flights (fixed-wing and helicopter) to and from the island.
- Laboratory costs include the original contract negotiated with Fruit Growers Laboratory. The contract money lasted through the inventory and covered routine monitoring laboratory analysis for about six months.

TABLE 23 - COST OF WATER QUALITY INVENTORY

TYPE OF PROGRAM	COST (K)
Personnel	24.5
Monitoring Equipment	6.8
Miscellaneous Supplies	1.3
Transportation	1.5
Database Design	2.0
Laboratory	10.9
TOTAL	**47.0**

CURRENT COST OF WATER QUALITY MONITORING

With the completion of the inventory, monitoring of water quality on Santa Rosa Island was scaled back. Currently, nine stations on three watersheds are monitored monthly. The work is performed by the range conservationist. There have been few equipment replacement costs.

Table 24 below lists the current costs of the program with the following explanations:

- Personnel costs include the estimated ¼ FTE for the range conservationist.
- Miscellaneous supplies include calibration supplies.
- Transportation includes transportation to and from the island.
- Laboratory costs include the cost to conduct the monthly laboratory analysis.

TABLE 24 - CURRENT COST OF WATER QUALITY MONITORING

TYPE OF PROGRAM	COST (K)
Personnel	10.6
Miscellaneous Supplies	1.0
Transportation	1.0
Laboratory	5.0
TOTAL	**17.6**

X. Appendix E — Data Tables

BY MONITORING EVENT

EVENT	SITE	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
ME01	L3	10/3/93	10:45	.018	19.0	18.2	7.500	2.350	0.000	0	9.440	0.50	0.05	5.0	1730	---	---
ME01	L4	10/3/93	14:00	.023	17.5	18.3	8.120	2.430	0.110	0	10.500	---	---	---	---	---	---
ME01	Q3	10/3/93	16:45	.046	16.7	22.7	8.780	4.130	0.210	0	9.960	0.50	0.30	5.0	3010	---	---
ME01	Q4	10/3/93	17:30	.050	17.8	22.7	8.670	4.410	2.300	3	9.850	---	---	---	---	---	---
ME01	W2	10/4/93	11:45	.044	15.6	20.5	8.280	2.700	0.100	1	11.220	---	---	---	---	---	---
ME01	W3	10/4/93	14:00	.168	21.7	24.1	8.550	2.430	0.100	2	11.550	0.50	0.05	5.0	1650	---	---
ME01	W4	10/4/93	15:45	.188	17.2	18.9	8.630	2.520	0.120	0	11.230	---	---	---	---	---	---
ME02	CS	10/13/93	11:17	---	15.6	18.2	8.320	0.509	0.020	0	8.300	---	---	---	---	---	---
ME02	L3	10/15/93	16:00	.007	20.6	18.5	7.420	2.400	0.110	0	8.540	0.50	0.05	5.0	1730	1300	1300
ME02	L4	10/15/93	15:15	.015	20.6	20.0	8.170	2.470	0.120	0	10.590	---	---	---	---	---	---
ME02	Q1	10/13/93	12:00	-.003	20.0	22.1	8.300	2.410	0.120	40	9.520	---	---	---	---	---	---
ME02	Q2	10/13/93	13:30	.058	17.8	21.8	8.370	3.840	0.180	26	9.850	---	---	---	---	---	---
ME02	Q3	10/13/93	15:45	.143	18.3	23.3	8.840	3.970	0.200	0	13.000	1.00	0.05	5.0	2970	1100	500
ME02	Q4	10/13/93	16:20	.038	16.7	22.3	8.940	4.770	0.240	2	11.280	---	---	---	---	---	---
ME02	W1	10/14/93	10:30	.003	13.9	---	---	---	---	---	---	---	---	---	---	---	---
ME02	W2	10/14/93	11:15	.068	18.3	20.9	8.320	1.350	0.150	0	10.510	---	---	---	---	---	---
ME02	W3	10/14/93	13:45	.188	19.4	23.8	8.470	2.470	0.120	0	10.170	1.00	0.05	5.0	1590	1300	500
ME02	W4	10/14/93	14:45	.222	18.9	20.4	8.670	2.500	0.120	0	11.900	---	---	---	---	---	---
ME03	CS	10/28/93	10:00	---	23.3	18.7	7.980	0.510	0.020	1	7.800	---	---	---	---	---	---

EVENT	SITE	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
ME03	L3	10/30/93	16:30	.011	18.3	16.4	7.370	2.270	0.100	0	8.260	0.50	0.05	5.0	1720	1100	0800
ME03	L4	10/30/93	15:45	.018	18.3	17.0	7.610	2.500	0.120	1	10.150	---	---	---	---	---	---
ME03	Q1	10/28/93	10:30	-.008	23.3	15.8	8.260	2.520	0.120	47	9.650	---	---	---	---	---	---
ME03	Q2	10/28/93	11:30	.049	25.0	18.0	8.180	3.950	0.200	81	9.570	---	---	---	---	---	---
ME03	Q3	10/28/93	14:00	.095	26.7	23.7	8.560	4.210	0.210	0	13.350	0.50	0.05	5.0	2940	2800	1700
ME03	Q4	10/28/93	13:15	.045	26.1	26.2	8.760	4.450	0.230	4	14.780	---	---	---	---	---	---
ME03	W2	10/30/93	9:45	.054	16.1	15.3	8.180	3.150	0.150	1	10.580	---	---	---	---	---	---
ME03	W3	10/30/93	12:30	.154	22.8	21.2	8.380	2.510	0.120	31	11.060	0.50	0.20	30.0	1620	2200	1100
ME03	W4	10/30/93	11:40	.215	18.3	15.7	8.450	2.560	0.120	4	11.100	---	---	---	---	---	---
ME04	CS	11/12/93	12:45	---	12.2	17.6	8.300	0.509	0.020	0	10.070	---	---	---	---	---	---
ME04	L3	11/12/93	9:40	.005	11.1	14.3	7.430	1.200	0.050	0	9.570	0.50	0.05	5.0	1750	500	500
ME04	L4	11/13/93	10:20	.015	14.4	13.0	7.960	2.550	0.120	57	11.640	---	---	---	---	---	---
ME04	Q1	11/12/93	13:15	-.004	11.7	13.9	7.500	2.370	0.110	441	9.240	---	---	---	---	---	---
ME04	Q2	11/12/93	14:15	.057	13.3	16.4	8.160	3.930	0.190	64	10.110	---	---	---	---	---	---
ME04	Q3	11/11/93	16:10	.128	13.3	14.6	8.250	4.220	0.210	0	9.540	0.50	0.05	5.0	2770	240	240
ME04	Q4	11/12/93	15:20	.065	13.3	16.9	8.500	4.480	0.230	4	11.990	---	---	---	---	---	---
ME04	W2	11/13/93	13:10	.047	12.2	14.6	8.200	3.200	0.150	5	10.300	---	---	---	---	---	---
ME04	W3	11/11/93	15:30	.183	13.3	16.0	8.220	2.580	0.120	7	9.520	0.50	0.05	10.0	1660	170	170
ME04	W4	11/13/93	12:00	.171	13.3	12.0	8.410	2.580	0.120	45	11.910	---	---	---	---	---	---
ME05	CS	11/21/93	9:00	---	16.7	15.7	8.150	0.509	0.020	0	8.430	---	---	---	---	---	---
ME05	L3	11/19/93	15:45	.009	10.6	14.5	7.320	2.530	0.120	0	8.190	0.50	0.05	5.0	1560	280	220
ME05	L4	11/19/93	14:00	.015	15.6	13.2	8.020	2.520	0.120	30	10.670	---	---	---	---	---	---

EVENT	SITE	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
ME05	Q1	11/21/93	9:30	-.005	17.8	12.8	8.310	1.710	0.070	40	9.600	---	---	---	---	---	---
ME05	Q2	11/21/93	10:30	.047	21.1	14.7	8.410	3.880	0.190	554	10.230	---	---	---	---	---	---
ME05	Q3	11/21/93	11:45	.086	19.4	15.1	8.570	4.140	0.210	6	14.430	0.50	0.05	5.0	2650	900	500
ME05	Q4	11/21/93	12:45	.061	18.9	18.4	8.510	4.370	0.220	6	12.680	---	---	---	---	---	---
ME05	W2	11/20/93	11:20	.036	18.3	15.5	8.370	3.080	0.150	25	10.700	---	---	---	---	---	---
ME05	W3	11/20/93	13:50	.157	19.4	16.7	8.500	2.450	0.110	35	10.590	0.50	0.10	10.0	1660	1600	500
ME05	W4	11/20/93	15:00	.138	15.6	14.6	8.720	2.410	0.110	13	11.640	---	---	---	---	---	---
ME06	CS	12/20/93	11:20	---	12.2	12.1	8.190	0.498	0.020	14	10.370	---	---	---	---	---	---
ME06	L1	12/18/93	14:15	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ME06	L2	12/18/93	15:40	.046	7.2	10.7	7.650	2.360	0.110	7	10.240	---	---	---	---	---	---
ME06	L3	12/18/93	16:20	.006	6.7	13.6	6.980	2.560	0.120	2	7.930	0.50	0.10	5.0	1620	300	170
ME06	L4	12/17/93	17:10	.041	7.2	11.6	7.500	2.800	0.130	2	9.140	---	---	---	---	---	---
ME06	Q1	12/20/93	11:40	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ME06	Q2	12/20/93	12:30	.046	15.6	13.0	8.130	3.900	0.190	71	10.560	---	---	---	---	---	---
ME06	Q3	12/20/93	13:50	.105	16.7	15.8	8.430	4.130	0.210	18	13.720	1.00	0.10	20.0	2630	260	110
ME06	Q4	12/20/93	14:20	.090	14.4	18.6	8.520	4.260	0.210	11	11.980	---	---	---	---	---	---
ME06	W1	12/19/93	12:30	.003	---	---	---	---	---	---	---	---	---	---	---	---	---
ME06	W2	12/19/93	13:50	.047	11.1	12.7	7.070	2.990	0.140	7	10.110	---	---	---	---	---	---
ME06	W3	12/19/93	15:10	.156	11.7	14.2	8.170	2.440	0.110	120	9.670	1.00	0.80	150.0	1500	1600	220
ME06	W4	12/19/93	17:00	.277	10.0	12.3	8.300	2.470	0.110	383	10.130	---	---	---	---	---	---
ME07	CS	1/5/94	9:15	---	12.2	12.4	8.170	0.503	0.020	1	10.140	---	---	---	---	---	---
ME07	L3	1/6/94	10:40	.009	11.7	13.9	7.270	2.600	0.120	1	9.480	2.00	0.10	5.0	1580	350	170

EVENT	SITE	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
ME07	L4	1/6/94	10:00	.025	12.2	10.7	7.570	2.560	0.120	27	11.350	---	---	---	---	---	---
ME07	Q2	1/5/94	10:15	.051	12.8	11.7	8.190	3.840	0.190	60	10.800	---	---	---	---	---	---
ME07	Q3	1/5/94	11:25	.145	15.0	16.3	8.450	4.110	0.200	3	15.570	0.50	0.50	5.0	2570	1600	1600
ME07	Q4	1/5/94	12:00	.062	15.0	17.3	8.580	4.140	0.210	5	12.900	---	---	---	---	---	---
ME07	W2	1/4/94	14:45	.026	12.2	14.0	6.970	3.230	0.150	1	11.130	---	---	---	---	---	---
ME07	W3	1/4/94	16:15	.100	11.7	14.1	8.150	2.480	0.110	2	10.060	0.50	0.05	5.0	1480	900	50
ME07	W4	1/4/94	17:00	.050	11.1	12.7	8.340	2.520	0.120	3	10.300	---	---	---	---	---	---
ME08	CS	1/22/94	9:40	---	16.7	15.3	8.150	0.502	0.020	1	8.250	---	---	---	---	---	---
ME08	L3	1/22/94	16:15	.019	12.8	15.0	7.300	2.620	0.120	0	8.570	0.50	0.20	5.0	1560	---	---
ME08	L4	1/22/94	15:45	.024	13.9	13.1	8.020	2.480	0.110	57	10.700	---	---	---	---	---	---
ME08	Q2	1/22/94	11:30	.062	18.3	14.4	8.270	1.260	0.050	115	11.030	---	---	---	---	---	---
ME08	Q3	1/22/94	12:25	.070	21.1	19.3	8.580	3.970	0.200	41	18.030	0.50	0.30	5.0	2600	---	---
ME08	Q4	1/22/94	12:45	.071	18.3	22.1	8.480	4.260	0.210	7	13.250	---	---	---	---	---	---
ME08	W2	1/21/94	15:20	.021	15.6	14.7	7.960	3.160	0.150	1	10.620	---	---	---	---	---	---
ME08	W3	1/21/94	16:40	.088	12.8	14.5	8.140	2.480	0.110	3	9.890	0.50	0.20	20.0	1770	---	---
ME08	W4	1/21/94	17:25	.108	14.4	12.5	8.490	2.520	0.120	1	10.030	---	---	---	---	---	---
ME09	L2	2/1/94	14:30	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ME09	L3	2/1/94	15:50	.018	12.2	14.0	7.210	2.680	0.130	1	9.880	0.50	0.10	20.0	1800	---	---
ME09	L4	2/1/94	15:15	.019	14.4	11.3	8.090	2.610	0.120	47	12.600	---	---	---	---	---	---
ME09	W2	2/2/94	10:10	.029	12.8	8.9	7.900	3.270	0.150	80	12.770	---	---	---	---	---	---
ME09	W3	2/2/94	11:45	.119	12.8	11.7	8.230	2.540	0.120	42	11.560	0.50	0.10	40.0	1600	---	---
ME09	W4	2/2/94	12:45	.184	12.8	10.2	8.450	2.570	0.120	35	12.960	---	---	---	---	---	---

EVENT	SITE	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
ME10	L3	2/16/94	13:45	.108	14.4	15.1	7.030	2.000	0.090	2	9.450	2.00	0.05	5.0	1300	---	---
ME10	Q3	2/16/94	9:20	.230	13.3	11.9	8.230	3.850	0.190	18	13.280	1.00	0.05	5.0	2400	---	---
ME10	W3	2/16/94	10:30	.324	13.9	13.4	8.120	2.030	0.090	298	10.030	1.00	1.10	160.0	1300	---	---
ME11	CS	3/6/94	9:25	---	12.2	14.9	7.880	0.473	0.010	3	8.110	---	---	---	---	---	---
ME11	L2	3/6/94	14:50	.000	---	---	---	---	---	---	---	---	---	---	---	---	---
ME11	L3	3/6/94	16:15	.189	12.2	15.1	7.040	1.920	0.090	1	9.720	2.00	0.20	5.0	1300	240	23
ME11	L4	3/6/94	15:50	.163	11.7	16.5	8.120	2.080	0.090	3	11.620	---	---	---	---	---	---
ME11	Q2	3/6/94	10:10	.160	15.0	15.5	8.480	3.300	0.160	4	14.130	---	---	---	---	---	---
ME11	Q3	3/6/94	11:10	.420	14.4	21.4	8.540	3.400	0.170	2	14.880	1.00	0.40	5.0	2300	9000	1700
ME11	Q4	3/6/94	11:50	.243	14.4	23.0	8.130	3.650	0.180	12	10.380	---	---	---	---	---	---
ME11	W2	3/7/94	9:55	.187	12.8	15.3	8.600	2.100	0.090	3	13.250	---	---	---	---	---	---
ME11	W3	3/7/94	11:40	.548	17.8	21.1	8.320	1.930	0.090	135	9.410	0.50	0.20	20.0	1200	5000	2400
ME11	W4	3/7/94	12:40	.662	15.6	18.7	8.390	2.010	0.090	130	10.690	---	---	---	---	---	---
ME12	L3	3/20/94	10:30	.117	17.8	16.4	6.980	1.970	0.090	10	9.570	2.00	0.10	5.0	1300	350	14
ME12	L4	3/20/94	10:00	.089	17.2	14.8	7.690	1.350	0.060	60	11.580	---	---	---	---	---	---
ME12	Q3	3/21/94	14:10	.171	16.1	24.9	8.270	3.640	0.180	13	10.110	1.00	0.40	5.0	2410	16000	5000
ME12	Q4	3/21/94	13:30	.165	21.1	26.5	8.100	3.940	0.200	23	9.780	---	---	---	---	---	---
ME12	W3	3/21/94	15:00	.248	17.2	22.3	8.200	2.090	0.100	237	8.320	2.00	0.20	140.0	1300	9000	3000
ME12	W4	3/21/94	16:00	.341	14.4	21.0	8.340	2.120	0.100	207	9.040	---	---	---	---	---	---
ME13	CS	3/31/94	10:15	---	15.6	16.8	7.920	0.475	0.010	3	8.610	---	---	---	---	---	---
ME13	L3	4/1/94	11:40	.048	17.8	17.3	7.050	1.940	0.090	1	9.950	2.00	0.05	5.0	1200	240	80
ME13	L4	4/1/94	11:00	.143	17.8	16.4	7.810	2.160	0.100	22	11.790	---	---	---	---	---	---

EVENT	SITE	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
ME13	Q2	3/31/94	11:00	.247	17.2	22.1	8.360	3.440	0.170	8	14.010	---	---	---	---	---	---
ME13	Q3	3/31/94	12:30	.238	17.8	26.5	8.620	3.590	0.180	6	14.720	0.50	0.05	5.0	2100	9000	9000
ME13	Q4	3/31/94	13:15	.109	17.8	26.6	8.140	3.910	0.200	3	10.690	---	---	---	---	---	---
ME13	W2	3/30/94	11:00	.098	14.4	21.0	8.030	2.290	0.110	218	8.740	---	---	---	---	---	---
ME13	W3	3/30/94	12:30	.424	17.8	25.0	8.210	2.050	0.090	288	8.500	0.50	0.30	130.0	1300	16000	16000
ME13	W4	3/30/94	14:45	.422	17.2	22.7	8.380	2.090	0.100	188	9.350	---	---	---	---	---	---
ME14	CS	4/16/94	10:15	---	12.2	15.9	7.930	0.487	0.020	3	7.950	---	---	---	---	---	---
ME14	L3	4/16/94	16:40	.013	15.6	15.5	7.030	2.010	0.090	0	9.410	2.00	0.05	5.0	1500	2400	0130
ME14	L4	4/16/94	16:00	.027	15.6	16.9	7.890	2.260	0.100	4	11.010	---	---	---	---	---	---
ME14	Q2	4/16/94	10:45	.123	15.0	17.0	8.280	3.580	0.180	3	14.130	---	---	---	---	---	---
ME14	Q3	4/16/94	12:00	.179	15.6	19.3	8.210	3.920	0.190	3	10.880	0.50	0.05	5.0	2700	2800	2800
ME14	Q4	4/16/94	12:40	.083	17.2	20.1	8.180	4.090	0.200	3	12.420	---	---	---	---	---	---
ME14	W2	4/17/94	10:20	.091	13.3	18.0	7.760	2.690	0.130	152	9.400	---	---	---	---	---	---
ME14	W3	4/17/94	12:00	.339	19.4	24.2	8.170	2.190	0.100	36	8.780	0.50	0.20	40.0	1400	5000	3000
ME14	W4	4/17/94	13:00	.399	16.1	21.4	8.300	2.260	0.100	9	9.580	---	---	---	---	---	---
ME15	CS	4/29/94	14:50	---	13.9	20.9	8.270	0.487	0.020	4	11.750	---	---	---	---	---	---
ME15	L3	4/30/94	11:20	.016	15.0	16.2	7.100	2.170	0.100	0	10.100	2.00	0.20	5.0	1500	1600	110
ME15	L4	4/30/94	10:30	.029	16.7	14.8	7.770	2.130	0.100	0	10.810	---	---	---	---	---	---
ME15	Q2	4/29/94	15:30	.045	16.1	25.7	8.300	3.530	0.170	4	10.470	---	---	---	---	---	---
ME15	Q3	4/29/94	16:20	.146	14.4	24.3	8.260	4.130	0.210	1	9.300	1.00	0.05	5.0	2500	17000	8000
ME15	Q4	4/29/94	17:00	.008	15.6	21.7	8.160	4.380	0.220	3	9.280	---	---	---	---	---	---
ME15	W2	4/30/94	14:25	.038	13.3	23.3	8.150	1.820	0.080	38	8.320	---	---	---	---	---	---

EVENT	SITE	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
ME15	W3	4/30/94	16:15	.130	13.3	21.7	8.210	2.340	0.110	60	8.890	0.50	0.50	50.0	1400	22000	5000
ME15	W4	4/30/94	17:00	.245	11.7	19.6	8.580	2.290	0.110	3	10.350	---	---	---	---	---	---
ME16	CS	5/14/94	5:00	---	12.2	15.7	7.780	0.493	0.020	1	7.050	---	---	---	---	---	---
ME16	L3	5/14/94	15:40	.021	16.7	18.7	7.160	2.220	0.100	5	11.090	1.00	0.05	5.0	1500	3000	2400
ME16	L4	5/14/94	14:30	.042	17.2	19.0	7.870	2.450	0.110	1	11.090	---	---	---	---	---	---
ME16	Q2	5/14/94	10:00	.082	19.4	15.9	8.070	3.670	0.180	8	11.600	---	---	---	---	---	---
ME16	Q3	5/14/94	11:00	.112	21.1	18.3	8.100	4.070	0.200	2	11.210	0.50	0.60	5.0	2800	9000	9000
ME16	Q4	5/14/94	11:35	.051	22.8	21.0	7.570	4.200	0.220	50	10.110	---	---	---	---	---	---
ME16	W2	5/15/94	11:40	.061	17.2	22.4	8.090	3.260	0.160	27	8.650	---	---	---	---	---	---
ME16	W3	5/15/94	9:00	.222	12.2	15.3	6.930	2.280	0.100	363	9.910	0.50	1.10	160.0	1500	3000	3000
ME16	W4	5/15/94	10:00	.232	12.8	15.0	8.260	2.320	0.110	73	11.260	---	---	---	---	5000	5000
ME17	CS	5/29/94	12:30	---	26.7	23.1	8.170	0.498	0.020	12	10.300	---	---	---	---	---	---
ME17	L3	5/30/94	15:15	.010	18.3	20.3	7.170	2.290	0.110	8	9.440	0.50	0.20	5.0	1500	130	0130
ME17	L4	5/30/94	14:15	.038	17.8	21.8	7.920	2.500	0.120	1	9.660	---	---	---	---	---	---
ME17	Q2	5/29/94		.076	23.3	28.7	8.200	3.780	0.190	11	11.200	---	---	---	---	---	---
ME17	Q3	5/29/94	10:45	.096	21.1	24.3	8.330	4.160	12.010	2	0.210	0.50	0.05	5.0	2600	1600	1600
ME17	Q4	5/29/94	11:30	.020	27.8	27.3	8.080	4.790	0.250	54	9.970	---	---	---	---	---	---
ME17	W2	5/29/94	17:00	.018	21.7	24.5	7.870	3.270	0.160	50	8.460	---	---	---	---	---	---
ME17	W3	5/29/94	14:00	.130	27.8	29.9	8.350	2.330	0.110	27	9.680	0.50	0.20	10.0	1400	3000	3000
ME17	W4	5/29/94	15:00	.163	22.2	27.5	8.450	2.370	0.110	9	9.240	---	---	---	---	---	---
ME18	CS	6/12/94	15:15	---	20.0	20.4	8.230	0.489	0.020	2	10.760	---	---	---	---	---	---
ME18	L3	6/13/94	13:00	.008	15.6	19.0	7.060	1.810	0.080	1	9.370	1.00	0.05	5.0	1500	1600	50

EVENT	SITE	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
ME18	L4	6/13/94	11:30	.030	16.7	17.1	7.690	2.560	0.120	1	10.100	---	---	---	---	---	---
ME18	Q2	6/12/94	14:30	.028	22.2	19.8	8.010	3.770	0.190	2	10.360	---	---	---	---	---	---
ME18	Q3	6/12/94	13:30	.075	19.4	22.3	8.220	4.310	0.220	4	13.290	0.50	0.10	5.0	2800	2400	1600
ME18	Q4	6/12/94	9:30	-.022	17.8	18.0	6.680	4.550	0.230	57	10.960	---	---	---	---	---	---
ME18	W3	6/12/94	15:45	.189	19.4	20.1	8.280	2.360	0.110	4	11.110	0.50	0.10	5.0	1400	3000	3000
ME18	W4	6/12/94	16:40	.193	15.6	19.4	8.350	2.470	0.120	1	10.430	---	---	---	---	---	---
ME19	CS	6/26/94	12:00	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ME19	L3	6/29/94	15:00	.008	17.8	20.6	7.160	2.410	0.110	17	8.830	1.00	0.05	5.0	1500	900	30
ME19	L4	6/27/94	14:15	.022	17.2	22.4	7.910	2.040	0.090	3	9.650	---	---	---	---	---	---
ME19	Q2	6/26/94	11:45	.080	31.1	27.2	7.940	3.990	0.200	2	10.900	---	---	---	---	---	---
ME19	Q3	6/26/94	10:45	.042	25.6	26.0	8.290	4.620	0.240	1	13.620	0.50	0.05	5.0	3000	3000	1600
ME19	Q4	6/26/94	10:00	-.029	23.3	23.4	8.050	4.940	0.250	9	11.730	---	---	---	---	---	---
ME19	W3	6/26/94	13:15	.105	32.2	31.0	8.280	2.520	0.120	1	11.190	0.50	0.05	5.0	1500	14000	3000
ME19	W4	6/26/94	14:15	.098	25.6	28.9	8.360	2.620	0.120	1	9.940	---	---	---	---	1700	500
ME20	CS	7/24/94	12:00	---	---	19.2	8.440	0.490	0.020	2	10.240	---	---	---	---	---	---
ME20	L3	7/25/94	11:30	.002	18.3	19.1	7.080	2.370	0.110	1	8.700	2.00	0.05	5.0	1800	110	110
ME20	L4	7/25/94	10:30	.022	18.3	17.8	7.560	2.180	0.100	13	9.130	---	---	---	---	---	---
ME20	Q2	7/24/94	11:30	.073	20.6	22.1	8.350	4.230	0.200	2	14.420	---	---	---	---	---	---
ME20	Q3	7/24/94	10:45	.031	20.6	22.0	8.400	4.650	0.240	1	13.430	1.00	0.05	5.0	3300	1600	1600
ME20	W3	7/24/94	13:15	.064	20.6	27.5	8.380	2.520	0.120	62	10.480	0.50	0.05	60.0	1600	9000	9000
ME20	W4	7/24/94	14:15	.137	19.4	25.9	8.430	2.610	0.120	7	9.740	---	---	---	---	---	---
ME21	CS	8/22/94	11:19	---	16.1	18.8	8.070	0.502	0.020	2	8.670	---	---	---	---	---	---

EVENT	SITE	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
ME21	L3	8/22/94	17:00	.008	18.3	20.2	7.240	2.550	0.120	7	8.420	0.50	0.05	20.0	2000	900	500
ME21	L4	8/22/94	15:10	.012	17.2	20.9	7.460	2.300	0.110	1	9.270	---	---	---	---	---	---
ME21	Q2	8/22/94	10:40	.033	16.7	19.3	8.100	4.130	0.210	1	12.170	---	---	---	---	---	---
ME21	Q3	8/22/94	9:00	.079	16.1	17.4	7.820	4.820	0.240	1	9.360	0.50	0.05	5.0	2800	1700	1700
ME21	W3	8/22/94	12:00	.094	16.1	21.0	8.140	2.570	2.120	23	10.330	0.50	0.05	40.0	1700	2400	2400
ME21	W4	8/22/94	12:50	.119	19.4	23.3	8.400	2.640	0.130	6	10.930	---	---	---	---	---	---
ME22	CS	9/1/94	11:20	---	18.3	18.0	7.970	0.493	0.020	4	9.130	---	---	---	---	---	---
ME22	L3	9/1/94	15:30	.000	17.8	17.7	7.230	2.580	0.120	1	10.870	0.50	0.20	5.0	1700	---	---
ME22	L4	9/1/94	14:25	.016	17.2	18.0	7.230	2.560	0.120	1	10.400	---	---	---	---	---	---
ME22	Q2	9/1/94	10:40	.044	17.2	18.3	7.970	4.040	0.200	3	12.520	---	---	---	---	---	---
ME22	Q3	9/1/94	9:30	.022	15.6	17.1	7.850	4.830	0.250	1	12.900	0.50	0.05	5.0	3200	---	---
ME22	W3	9/1/94	12:00	.113	17.8	21.6	8.190	2.540	0.120	53	11.300	0.50	0.80	40.0	1600	---	---
ME22	W4	9/1/94	13:00	.067	16.1	20.7	8.270	2.610	0.120	6	11.900	---	---	---	---	---	---
ME23	CS	10/17/94	10:40	---	16.7	16.0	8.150	0.505	0.020	4	8.250	---	---	---	---	---	---
ME23	L3	10/17/94	15:15	-.007	16.7	19.2	7.760	2.710	0.130	1	10.150	0.60	0.05	5.0	1800	---	---
ME23	L4	10/17/94	14:15	.012	15.6	15.6	7.880	2.360	0.110	9	11.200	---	---	---	---	---	---
ME23	Q2	10/17/94	10:00	.032	18.3	10.0	8.090	3.890	0.190	163	11.670	---	---	---	---	---	---
ME23	Q3	10/17/94	8:50	.030	16.7	10.0	7.860	4.700	0.230	116	12.500	0.50	0.05	5.0	3000	---	---
ME23	W3	10/17/94	11:15	.093	19.4	17.2	8.290	2.620	0.120	23	12.880	0.50	0.05	30.0	1600	---	---
ME23	W4	10/17/94	12:10	.052	16.7	13.3	8.320	2.680	0.130	15	14.000	---	---	---	---	---	---
ME24	CS	10/24/94	11:15	---	16.1	17.2	8.190	0.500	0.020	10	9.280	---	---	---	---	---	---
ME24	L3	10/24/94	15:30	-.002	17.2	18.4	7.640	2.730	0.130	1	11.460	0.50	0.30	10.0	1900	900	500

EVENT	SITE	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
ME24	L4	10/24/94	14:10	.019	15.6	16.6	7.900	2.610	0.120	1	9.580	---	---	---	---	---	---
ME24	Q2	10/24/94	10:15	.019	16.1	14.3	8.100	4.000	0.200	160	10.280	---	---	---	---	---	---
ME24	Q3	10/24/94	9:40	.023	17.8	15.5	8.010	4.440	0.220	1	12.140	0.50	0.40	10.0	3000	300	170
ME24	W3	10/24/94	11:45	.118	17.2	20.2	8.260	2.560	0.120	28	11.660	0.50	0.20	20.0	1600	2400	1600
ME24	W4	10/24/94	12:45	.075	18.3	15.7	8.430	2.610	0.120	115	11.470	---	---	---	---	---	---
ME25	CS	10/31/94	10:30	---	21.7	19.3	8.000	0.486	0.020	5	9.360	---	---	---	---	---	---
ME25	L3	10/31/94	15:30	-.003	17.2	16.3	7.210	2.730	0.130	1	8.110	0.50	0.60	5.0	1700	300	130
ME25	L4	10/31/94	14:00	.015	19.4	15.5	7.600	2.600	0.120	5	9.830	---	---	---	---	---	---
ME25	Q2	10/31/94	9:45	.009	21.7	14.3	7.930	3.940	0.190	285	9.630	---	---	---	---	---	---
ME25	Q3	10/31/94	8:45	.024	18.3	15.2	7.920	4.340	0.220	11	12.480	0.50	1.10	5.0	2600	130	130
ME25	W3	10/31/94	11:00	.055	24.4	20.0	7.790	2.610	0.120	140	10.800	0.50	0.50	30.0	1500	1600	900
ME25	W4	10/31/94	11:50	.088	25.0	14.9	8.150	2.580	0.120	5	11.900	---	---	---	---	---	---
ME26	CS	12/3/94	11:00	---	11.1	12.7	8.020	0.497	0.020	---	8.350	---	---	---	---	---	---
ME26	L4	12/3/94	15:00	.012	12.2	12.8	7.710	2.660	0.120	---	10.290	---	---	---	---	---	---
ME26	Q2	12/3/94	10:25	.039	10.6	11.8	8.020	3.900	0.190	---	10.410	---	---	---	---	---	---
ME26	Q3	12/4/94	10:40	.054	12.8	15.5	8.180	4.290	0.210	---	14.420	0.50	0.60	5.0	2900	130	30
ME26	W3	12/3/94	11:35	.102	13.9	14.0	8.110	2.520	0.120	---	10.360	0.50	1.20	10.0	1600	900	240
ME26	W4	12/3/94	12:20	.105	12.2	12.7	8.270	2.540	0.120	---	11.190	---	---	---	---	---	---

BY SITE

SITE	EVENT	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
CS	ME02	10/13/93	11:17	---	15.6	18.2	8.320	0.509	0.020	0	8.300	---	---	---	---	---	---
CS	ME03	10/28/93	10:00	---	23.3	18.7	7.980	0.510	0.020	1	7.800	---	---	---	---	---	---
CS	ME04	11/12/93	12:45	---	12.2	17.6	8.300	0.509	0.020	0	10.070	---	---	---	---	---	---
CS	ME05	11/21/93	9:00	---	16.7	15.7	8.150	0.509	0.020	0	8.430	---	---	---	---	---	---
CS	ME06	12/20/93	11:20	---	12.2	12.1	8.190	0.498	0.020	14	10.370	---	---	---	---	---	---
CS	ME07	1/5/94	9:15	---	12.2	12.4	8.170	0.503	0.020	1	10.140	---	---	---	---	---	---
CS	ME08	1/22/94	9:40	---	16.7	15.3	8.150	0.502	0.020	1	8.250	---	---	---	---	---	---
CS	ME11	3/6/94	9:25	---	12.2	14.9	7.880	0.473	0.010	3	8.110	---	---	---	---	---	---
CS	ME13	3/31/94	10:15	---	15.6	16.8	7.920	0.475	0.010	3	8.610	---	---	---	---	---	---
CS	ME14	4/16/94	10:15	---	12.2	15.9	7.930	0.487	0.020	3	7.950	---	---	---	---	---	---
CS	ME15	4/29/94	14:50	---	13.9	20.9	8.270	0.487	0.020	4	11.750	---	---	---	---	---	---
CS	ME16	5/14/94	5:00	---	12.2	15.7	7.780	0.493	0.020	1	7.050	---	---	---	---	---	---
CS	ME17	5/29/94	12:30	---	26.7	23.1	8.170	0.498	0.020	12	10.300	---	---	---	---	---	---
CS	ME18	6/12/94	15:15	---	20.0	20.4	8.230	0.489	0.020	2	10.760	---	---	---	---	---	---
CS	ME19	6/26/94	12:00	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CS	ME20	7/24/94	12:00	---	---	19.2	8.440	0.490	0.020	2	10.240	---	---	---	---	---	---
CS	ME21	8/22/94	11:19	---	16.1	18.8	8.070	0.502	0.020	2	8.670	---	---	---	---	---	---
CS	ME22	9/1/94	11:20	---	18.3	18.0	7.970	0.493	0.020	4	9.130	---	---	---	---	---	---
CS	ME23	10/17/94	10:40	---	16.7	16.0	8.150	0.505	0.020	4	8.250	---	---	---	---	---	---
CS	ME24	10/24/94	11:15	---	16.1	17.2	8.190	0.500	0.020	10	9.280	---	---	---	---	---	---
CS	ME25	10/31/94	10:30	---	21.7	19.3	8.000	0.486	0.020	5	9.360	---	---	---	---	---	---

SITE	EVENT	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
CS	ME26	12/3/94	11:00	---	11.1	12.7	8.020	0.497	0.020	---	8.350	---	---	---	---	---	---
L1	ME06	12/18/93	14:15	---	---	---	---	---	---	---	---	---	---	---	---	---	---
L2	ME06	12/18/93	15:40	.046	7.2	10.7	7.650	2.360	0.110	7	10.240	---	---	---	---	---	---
L2	ME09	2/1/94	14:30	---	---	---	---	---	---	---	---	---	---	---	---	---	---
L2	ME11	3/6/94	14:50	.000	---	---	---	---	---	---	---	---	---	---	---	---	---
L3	ME01	10/3/93	10:45	.018	19.0	18.2	7.500	2.350	0.000	0	9.440	0.50	0.05	5.0	1730	---	---
L3	ME02	10/15/93	16:00	.007	20.6	18.5	7.420	2.400	0.110	0	8.540	0.50	0.05	5.0	1730	1300	1300
L3	ME03	10/30/93	16:30	.011	18.3	16.4	7.370	2.270	0.100	0	8.260	0.50	0.05	5.0	1720	1100	800
L3	ME04	11/12/93	9:40	.005	11.1	14.3	7.430	1.200	0.050	0	9.570	0.50	0.05	5.0	1750	500	500
L3	ME05	11/19/93	15:45	.009	10.6	14.5	7.320	2.530	0.120	0	8.190	0.50	0.05	5.0	1560	280	220
L3	ME06	12/18/93	16:20	.006	6.7	13.6	6.980	2.560	0.120	2	7.930	0.50	0.10	5.0	1620	300	170
L3	ME07	1/6/94	10:40	.009	11.7	13.9	7.270	2.600	0.120	1	9.480	2.00	0.10	5.0	1580	350	170
L3	ME08	1/22/94	16:15	.019	12.8	15.0	7.300	2.620	0.120	0	8.570	0.50	0.20	5.0	1560	---	---
L3	ME09	2/1/94	15:50	.018	12.2	14.0	7.210	2.680	0.130	1	9.880	0.50	0.10	20.0	1800	---	---
L3	ME10	2/16/94	13:45	.108	14.4	15.1	7.030	2.000	0.090	2	9.450	2.00	0.05	5.0	1300	---	---
L3	ME11	3/6/94	16:15	.189	12.2	15.1	7.040	1.920	0.090	1	9.720	2.00	0.20	5.0	1300	240	23
L3	ME12	3/20/94	10:30	.117	17.8	16.4	6.980	1.970	0.090	10	9.570	2.00	0.10	5.0	1300	350	14
L3	ME13	4/1/94	11:40	.048	17.8	17.3	7.050	1.940	0.090	1	9.950	2.00	0.05	5.0	1200	240	80
L3	ME14	4/16/94	16:40	.013	15.6	15.5	7.030	2.010	0.090	0	9.410	2.00	0.05	5.0	1500	2400	130
L3	ME15	4/30/94	11:20	.016	15.0	16.2	7.100	2.170	0.100	0	10.100	2.00	0.20	5.0	1500	1600	110
L3	ME16	5/14/94	15:40	.021	16.7	18.7	7.160	2.220	0.100	5	11.090	1.00	0.05	5.0	1500	3000	2400
L3	ME17	5/30/94	15:15	.010	18.3	20.3	7.170	2.290	0.110	8	9.440	0.50	0.20	5.0	1500	130	130

SITE	EVENT	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
L3	ME18	6/13/94	13:00	.008	15.6	19.0	7.060	1.810	0.080	1	9.370	1.00	0.05	5.0	1500	1600	50
L3	ME19	6/29/94	15:00	.008	17.8	20.6	7.160	2.410	0.110	17	8.830	1.00	0.05	5.0	1500	900	30
L3	ME20	7/25/94	11:30	.002	18.3	19.1	7.080	2.370	0.110	1	8.700	2.00	0.05	5.0	1800	110	110
L3	ME21	8/22/94	17:00	.008	18.3	20.2	7.240	2.550	0.120	7	8.420	0.50	0.05	20.0	2000	900	500
L3	ME22	9/1/94	15:30	.000	17.8	17.7	7.230	2.580	0.120	1	10.870	0.50	0.20	5.0	1700	---	---
L3	ME23	10/17/94	15:15	-.007	16.7	19.2	7.760	2.710	0.130	1	10.150	0.60	0.05	5.0	1800	---	---
L3	ME24	10/24/94	15:30	-.002	17.2	18.4	7.640	2.730	0.130	1	11.460	0.50	0.30	10.0	1900	900	500
L3	ME25	10/31/94	15:30	-.003	17.2	16.3	7.210	2.730	0.130	1	8.110	0.50	0.60	5.0	1700	300	130
L4	ME01	10/3/93	14:00	.023	17.5	18.3	8.120	2.430	0.110	0	10.500	---	---	---	---	---	---
L4	ME02	10/15/93	15:15	.015	20.6	20.0	8.170	2.470	0.120	0	10.590	---	---	---	---	---	---
L4	ME03	10/30/93	15:45	.018	18.3	17.0	7.610	2.500	0.120	1	10.150	---	---	---	---	---	---
L4	ME04	11/13/93	10:20	.015	14.4	13.0	7.960	2.550	0.120	57	11.640	---	---	---	---	---	---
L4	ME05	11/19/93	14:00	.015	15.6	13.2	8.020	2.520	0.120	30	10.670	---	---	---	---	---	---
L4	ME06	12/17/93	17:10	.041	7.2	11.6	7.500	2.800	0.130	2	9.140	---	---	---	---	---	---
L4	ME07	1/6/94	10:00	.025	12.2	10.7	7.570	2.560	0.120	27	11.350	---	---	---	---	---	---
L4	ME08	1/22/94	15:45	.024	13.9	13.1	8.020	2.480	0.110	57	10.700	---	---	---	---	---	---
L4	ME09	2/1/94	15:15	.019	14.4	11.3	8.090	2.610	0.120	47	12.600	---	---	---	---	---	---
L4	ME11	3/6/94	15:50	.163	11.7	16.5	8.120	2.080	0.090	3	11.620	---	---	---	---	---	---
L4	ME12	3/20/94	10:00	.089	17.2	14.8	7.690	1.350	0.060	60	11.580	---	---	---	---	---	---
L4	ME13	4/1/94	11:00	.143	17.8	16.4	7.810	2.160	0.100	22	11.790	---	---	---	---	---	---
L4	ME14	4/16/94	16:00	.027	15.6	16.9	7.890	2.260	0.100	4	11.010	---	---	---	---	---	---
L4	ME15	4/30/94	10:30	.029	16.7	14.8	7.770	2.130	0.100	0	10.810	---	---	---	---	---	---

SITE	EVENT	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
L4	ME16	5/14/94	14:30	.042	17.2	19.0	7.870	2.450	0.110	1	11.090	---	---	---	---	---	---
L4	ME17	5/30/94	14:15	.038	17.8	21.8	7.920	2.500	0.120	1	9.660	---	---	---	---	---	---
L4	ME18	6/13/94	11:30	.030	16.7	17.1	7.690	2.560	0.120	1	10.100	---	---	---	---	---	---
L4	ME19	6/27/94	14:15	.022	17.2	22.4	7.910	2.040	0.090	3	9.650	---	---	---	---	---	---
L4	ME20	7/25/94	10:30	.022	18.3	17.8	7.560	2.180	0.100	13	9.130	---	---	---	---	---	---
L4	ME21	8/22/94	15:10	.012	17.2	20.9	7.460	2.300	0.110	1	9.270	---	---	---	---	---	---
L4	ME22	9/1/94	14:25	.016	17.2	18.0	7.230	2.560	0.120	1	10.400	---	---	---	---	---	---
L4	ME23	10/17/94	14:15	.012	15.6	15.6	7.880	2.360	0.110	9	11.200	---	---	---	---	---	---
L4	ME24	10/24/94	14:10	.019	15.6	16.6	7.900	2.610	0.120	1	9.580	---	---	---	---	---	---
L4	ME25	10/31/94	14:00	.015	19.4	15.5	7.600	2.600	0.120	5	9.830	---	---	---	---	---	---
L4	ME26	12/3/94	15:00	.012	12.2	12.8	7.710	2.660	0.120	---	10.290	---	---	---	---	---	---
Q1	ME02	10/13/93	12:00	-.003	20.0	22.1	8.300	2.410	0.120	40	9.520	---	---	---	---	---	---
Q1	ME03	10/28/93	10:30	-.008	23.3	15.8	8.260	2.520	0.120	47	9.650	---	---	---	---	---	---
Q1	ME04	11/12/93	13:15	-.004	11.7	13.9	7.500	2.370	0.110	441	9.240	---	---	---	---	---	---
Q1	ME05	11/21/93	9:30	-.005	17.8	12.8	8.310	1.710	0.070	40	9.600	---	---	---	---	---	---
Q1	ME06	12/20/93	11:40	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Q2	ME02	10/13/93	13:30	.058	17.8	21.8	8.370	3.840	0.180	26	9.850	---	---	---	---	---	---
Q2	ME03	10/28/93	11:30	.049	25.0	18.0	8.180	3.950	0.200	81	9.570	---	---	---	---	---	---
Q2	ME04	11/12/93	14:15	.057	13.3	16.4	8.160	3.930	0.190	64	10.110	---	---	---	---	---	---
Q2	ME05	11/21/93	10:30	.047	21.1	14.7	8.410	3.880	0.190	554	10.230	---	---	---	---	---	---
Q2	ME06	12/20/93	12:30	.046	15.6	13.0	8.130	3.900	0.190	71	10.560	---	---	---	---	---	---
Q2	ME07	1/5/94	10:15	.051	12.8	11.7	8.190	3.840	0.190	60	10.800	---	---	---	---	---	---

SITE	EVENT	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
Q2	ME08	1/22/94	11:30	.062	18.3	14.4	8.270	1.260	0.050	115	11.030	---	---	---	---	---	---
Q2	ME11	3/6/94	10:10	.160	15.0	15.5	8.480	3.300	0.160	4	14.130	---	---	---	---	---	---
Q2	ME13	3/31/94	11:00	.247	17.2	22.1	8.360	3.440	0.170	8	14.010	---	---	---	---	---	---
Q2	ME14	4/16/94	10:45	.123	15.0	17.0	8.280	3.580	0.180	3	14.130	---	---	---	---	---	---
Q2	ME15	4/29/94	15:30	.045	16.1	25.7	8.300	3.530	0.170	4	10.470	---	---	---	---	---	---
Q2	ME16	5/14/94	10:00	.082	19.4	15.9	8.070	3.670	0.180	8	11.600	---	---	---	---	---	---
Q2	ME17	5/29/94	---	.076	23.3	28.7	8.200	3.780	0.190	11	11.200	---	---	---	---	---	---
Q2	ME18	6/12/94	14:30	.028	22.2	19.8	8.010	3.770	0.190	2	10.360	---	---	---	---	---	---
Q2	ME19	6/26/94	11:45	.080	31.1	27.2	7.940	3.990	0.200	2	10.900	---	---	---	---	---	---
Q2	ME20	7/24/94	11:30	.073	20.6	22.1	8.350	4.230	0.200	2	14.420	---	---	---	---	---	---
Q2	ME21	8/22/94	10:40	.033	16.7	19.3	8.100	4.130	0.210	1	12.170	---	---	---	---	---	---
Q2	ME22	9/1/94	10:40	.044	17.2	18.3	7.970	4.040	0.200	3	12.520	---	---	---	---	---	---
Q2	ME23	10/17/94	10:00	.032	18.3	10.0	8.090	3.890	0.190	163	11.670	---	---	---	---	---	---
Q2	ME24	10/24/94	10:15	.019	16.1	14.3	8.100	4.000	0.200	160	10.280	---	---	---	---	---	---
Q2	ME25	10/31/94	9:45	.009	21.7	14.3	7.930	3.940	0.190	285	9.630	---	---	---	---	---	---
Q2	ME26	12/3/94	10:25	.039	10.6	11.8	8.020	3.900	0.190	---	10.410	---	---	---	---	---	---
Q3	ME01	10/3/93	16:45	.046	16.7	22.7	8.780	4.130	0.210	0	9.960	0.50	0.30	5.0	3010	---	---
Q3	ME02	10/13/93	15:45	.143	18.3	23.3	8.840	3.970	0.200	0	13.000	1.00	0.05	5.0	2970	1100	500
Q3	ME03	10/28/93	14:00	.095	26.7	23.7	8.560	4.210	0.210	0	13.350	0.50	0.05	5.0	2940	2800	1700
Q3	ME04	11/11/93	16:10	.128	13.3	14.6	8.250	4.220	0.210	0	9.540	0.50	0.05	5.0	2770	240	240
Q3	ME05	11/21/93	11:45	.086	19.4	15.1	8.570	4.140	0.210	6	14.430	0.50	0.05	5.0	2650	900	500
Q3	ME06	12/20/93	13:50	.105	16.7	15.8	8.430	4.130	0.210	18	13.720	1.00	0.10	20.0	2630	260	110

SITE	EVENT	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
Q3	ME07	1/5/94	11:25	.145	15.0	16.3	8.450	4.110	0.200	3	15.570	0.50	0.50	5.0	2570	1600	1600
Q3	ME08	1/22/94	12:25	.070	21.1	19.3	8.580	3.970	0.200	41	18.030	0.50	0.30	5.0	2600	---	---
Q3	ME10	2/16/94	9:20	.230	13.3	11.9	8.230	3.850	0.190	18	13.280	1.00	0.05	5.0	2400	---	---
Q3	ME11	3/6/94	11:10	.420	14.4	21.4	8.540	3.400	0.170	2	14.880	1.00	0.40	5.0	2300	9000	1700
Q3	ME12	3/21/94	14:10	.171	16.1	24.9	8.270	3.640	0.180	13	10.110	1.00	0.40	5.0	2410	16000	5000
Q3	ME13	3/31/94	12:30	.238	17.8	26.5	8.620	3.590	0.180	6	14.720	0.50	0.05	5.0	2100	9000	9000
Q3	ME14	4/16/94	12:00	.179	15.6	19.3	8.210	3.920	0.190	3	10.880	0.50	0.05	5.0	2700	2800	2800
Q3	ME15	4/29/94	16:20	.146	14.4	24.3	8.260	4.130	0.210	1	9.300	1.00	0.05	5.0	2500	17000	8000
Q3	ME16	5/14/94	11:00	.112	21.1	18.3	8.100	4.070	0.200	2	11.210	0.50	0.60	5.0	2800	9000	9000
Q3	ME17	5/29/94	10:45	.096	21.1	24.3	8.330	4.160	12.010	2	0.210	0.50	0.05	5.0	2600	1600	1600
Q3	ME18	6/12/94	13:30	.075	19.4	22.3	8.220	4.310	0.220	4	13.290	0.50	0.10	5.0	2800	2400	1600
Q3	ME19	6/26/94	10:45	.042	25.6	26.0	8.290	4.620	0.240	1	13.620	0.50	0.05	5.0	3000	3000	1600
Q3	ME20	7/24/94	10:45	.031	20.6	22.0	8.400	4.650	0.240	1	13.430	1.00	0.05	5.0	3300	1600	1600
Q3	ME21	8/22/94	9:00	.079	16.1	17.4	7.820	4.820	0.240	1	9.360	0.50	0.05	5.0	2800	1700	1700
Q3	ME22	9/1/94	9:30	.022	15.6	17.1	7.850	4.830	0.250	1	12.900	0.50	0.05	5.0	3200	---	---
Q3	ME23	10/17/94	8:50	.030	16.7	10.0	7.860	4.700	0.230	116	12.500	0.50	0.05	5.0	3000	---	---
Q3	ME24	10/24/94	9:40	.023	17.8	15.5	8.010	4.440	0.220	1	12.140	0.50	0.40	10.0	3000	300	170
Q3	ME25	10/31/94	8:45	.024	18.3	15.2	7.920	4.340	0.220	11	12.480	0.50	1.10	5.0	2600	130	130
Q3	ME26	12/4/94	10:40	.054	12.8	15.5	8.180	4.290	0.210	---	14.420	0.50	0.60	5.0	2900	130	30
Q4	ME01	10/3/93	17:30	.050	17.8	22.7	8.670	4.410	2.300	3	9.850	---	---	---	---	---	---
Q4	ME02	10/13/93	16:20	.038	16.7	22.3	8.940	4.770	0.240	2	11.280	---	---	---	---	---	---
Q4	ME03	10/28/93	13:15	.045	26.1	26.2	8.760	4.450	0.230	4	14.780	---	---	---	---	---	---

SITE	EVENT	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
Q4	ME04	11/12/93	15:20	.065	13.3	16.9	8.500	4.480	0.230	4	11.990	---	---	---	---	---	---
Q4	ME05	11/21/93	12:45	.061	18.9	18.4	8.510	4.370	0.220	6	12.680	---	---	---	---	---	---
Q4	ME06	12/20/93	14:20	.090	14.4	18.6	8.520	4.260	0.210	11	11.980	---	---	---	---	---	---
Q4	ME07	1/5/94	12:00	.062	15.0	17.3	8.580	4.140	0.210	5	12.900	---	---	---	---	---	---
Q4	ME08	1/22/94	12:45	.071	18.3	22.1	8.480	4.260	0.210	7	13.250	---	---	---	---	---	---
Q4	ME11	3/6/94	11:50	.243	14.4	23.0	8.130	3.650	0.180	12	10.380	---	---	---	---	---	---
Q4	ME12	3/21/94	13:30	.165	21.1	26.5	8.100	3.940	0.200	23	9.780	---	---	---	---	---	---
Q4	ME13	3/31/94	13:15	.109	17.8	26.6	8.140	3.910	0.200	3	10.690	---	---	---	---	---	---
Q4	ME14	4/16/94	12:40	.083	17.2	20.1	8.180	4.090	0.200	3	12.420	---	---	---	---	---	---
Q4	ME15	4/29/94	17:00	.008	15.6	21.7	8.160	4.380	0.220	3	9.280	---	---	---	---	---	---
Q4	ME16	5/14/94	11:35	.051	22.8	21.0	7.570	4.200	0.220	50	10.110	---	---	---	---	---	---
Q4	ME17	5/29/94	11:30	.020	27.8	27.3	8.080	4.790	0.250	54	9.970	---	---	---	---	---	---
Q4	ME18	6/12/94	9:30	-.022	17.8	18.0	6.680	4.550	0.230	57	10.960	---	---	---	---	---	---
Q4	ME19	6/26/94	10:00	-.029	23.3	23.4	8.050	4.940	0.250	9	11.730	---	---	---	---	---	---
W1	ME02	10/14/93	10:30	.003	13.9	---	---	---	---	---	---	---	---	---	---	---	---
W1	ME06	12/19/93	12:30	.003	---	---	---	---	---	---	---	---	---	---	---	---	---
W2	ME01	10/4/93	11:45	.044	15.6	20.5	8.280	2.700	0.100	1	11.220	---	---	---	---	---	---
W2	ME02	10/14/93	11:15	.068	18.3	20.9	8.320	1.350	0.150	0	10.510	---	---	---	---	---	---
W2	ME03	10/30/93	9:45	.054	16.1	15.3	8.180	3.150	0.150	1	10.580	---	---	---	---	---	---
W2	ME04	11/13/93	13:10	.047	12.2	14.6	8.200	3.200	0.150	5	10.300	---	---	---	---	---	---
W2	ME05	11/20/93	11:20	.036	18.3	15.5	8.370	3.080	0.150	25	10.700	---	---	---	---	---	---
W2	ME06	12/19/93	13:50	.047	11.1	12.7	7.070	2.990	0.140	7	10.110	---	---	---	---	---	---

SITE	EVENT	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
W2	ME07	1/4/94	14:45	.026	12.2	14.0	6.970	3.230	0.150	1	11.130	---	---	---	---	---	---
W2	ME08	1/21/94	15:20	.021	15.6	14.7	7.960	3.160	0.150	1	10.620	---	---	---	---	---	---
W2	ME09	2/2/94	10:10	.029	12.8	8.9	7.900	3.270	0.150	80	12.770	---	---	---	---	---	---
W2	ME11	3/7/94	9:55	.187	12.8	15.3	8.600	2.100	0.090	3	13.250	---	---	---	---	---	---
W2	ME13	3/30/94	11:00	.098	14.4	21.0	8.030	2.290	0.110	218	8.740	---	---	---	---	---	---
W2	ME14	4/17/94	10:20	.091	13.3	18.0	7.760	2.690	0.130	152	9.400	---	---	---	---	---	---
W2	ME15	4/30/94	14:25	.038	13.3	23.3	8.150	1.820	0.080	38	8.320	---	---	---	---	---	---
W2	ME16	5/15/94	11:40	.061	17.2	22.4	8.090	3.260	0.160	27	8.650	---	---	---	---	---	---
W2	ME17	5/29/94	17:00	.018	21.7	24.5	7.870	3.270	0.160	50	8.460	---	---	---	---	---	---
W3	ME01	10/4/93	14:00	.168	21.7	24.1	8.550	2.430	0.100	2	11.550	0.50	0.05	5.0	1650	---	---
W3	ME02	10/14/93	13:45	.188	19.4	23.8	8.470	2.470	0.120	0	10.170	1.00	0.05	5.0	1590	1300	500
W3	ME03	10/30/93	12:30	.154	22.8	21.2	8.380	2.510	0.120	31	11.060	0.50	0.20	30.0	1620	2200	1100
W3	ME04	11/11/93	15:30	.183	13.3	16.0	8.220	2.580	0.120	7	9.520	0.50	0.05	10.0	1660	170	170
W3	ME05	11/20/93	13:50	.157	19.4	16.7	8.500	2.450	0.110	35	10.590	0.50	0.10	10.0	1660	1600	500
W3	ME06	12/19/93	15:10	.156	11.7	14.2	8.170	2.440	0.110	120	9.670	1.00	0.80	150.0	1500	1600	220
W3	ME07	1/4/94	16:15	.100	11.7	14.1	8.150	2.480	0.110	2	10.060	0.50	0.05	5.0	1480	900	50
W3	ME08	1/21/94	16:40	.088	12.8	14.5	8.140	2.480	0.110	3	9.890	0.50	0.20	20.0	1770	---	---
W3	ME09	2/2/94	11:45	.119	12.8	11.7	8.230	2.540	0.120	42	11.560	0.50	0.10	40.0	1600	---	---
W3	ME10	2/16/94	10:30	.324	13.9	13.4	8.120	2.030	0.090	298	10.030	1.00	1.10	160.0	1300	---	---
W3	ME11	3/7/94	11:40	.548	17.8	21.1	8.320	1.930	0.090	135	9.410	0.50	0.20	20.0	1200	5000	2400
W3	ME12	3/21/94	15:00	.248	17.2	22.3	8.200	2.090	0.100	237	8.320	2.00	0.20	140.0	1300	9000	3000
W3	ME13	3/30/94	12:30	.424	17.8	25.0	8.210	2.050	0.090	288	8.500	0.50	0.30	130.0	1300	16000	16000

SITE	EVENT	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
W3	ME14	4/17/94	12:00	.339	19.4	24.2	8.170	2.190	0.100	36	8.780	0.50	0.20	40.0	1400	5000	3000
W3	ME15	4/30/94	16:15	.130	13.3	21.7	8.210	2.340	0.110	60	8.890	0.50	0.50	50.0	1400	22000	5000
W3	ME16	5/15/94	9:00	.222	12.2	15.3	6.930	2.280	0.100	363	9.910	0.50	1.10	160.0	1500	3000	3000
W3	ME17	5/29/94	14:00	.130	27.8	29.9	8.350	2.330	0.110	27	9.680	0.50	0.20	10.0	1400	3000	3000
W3	ME18	6/12/94	15:45	.189	19.4	20.1	8.280	2.360	0.110	4	11.110	0.50	0.10	5.0	1400	3000	3000
W3	ME19	6/26/94	13:15	.105	32.2	31.0	8.280	2.520	0.120	1	11.190	0.50	0.05	5.0	1500	14000	3000
W3	ME20	7/24/94	13:15	.064	20.6	27.5	8.380	2.520	0.120	62	10.480	0.50	0.05	60.0	1600	9000	9000
W3	ME21	8/22/94	12:00	.094	16.1	21.0	8.140	2.570	2.120	23	10.330	0.50	0.05	40.0	1700	2400	2400
W3	ME22	9/1/94	12:00	.113	17.8	21.6	8.190	2.540	0.120	53	11.300	0.50	0.80	40.0	1600	---	---
W3	ME23	10/17/94	11:15	.093	19.4	17.2	8.290	2.620	0.120	23	12.880	0.50	0.05	30.0	1600	---	---
W3	ME24	10/24/94	11:45	.118	17.2	20.2	8.260	2.560	0.120	28	11.660	0.50	0.20	20.0	1600	2400	1600
W3	ME25	10/31/94	11:00	.055	24.4	20.0	7.790	2.610	0.120	140	10.800	0.50	0.50	30.0	1500	1600	900
W3	ME26	12/3/94	11:35	.102	13.9	14.0	8.110	2.520	0.120	---	10.360	0.50	1.20	10.0	1600	900	240
W4	ME01	10/4/93	15:45	.188	17.2	18.9	8.630	2.520	0.120	0	11.230	---	---	---	---	---	---
W4	ME02	10/14/93	14:45	.222	18.9	20.4	8.670	2.500	0.120	0	11.900	---	---	---	---	---	---
W4	ME03	10/30/93	11:40	.215	18.3	15.7	8.450	2.560	0.120	4	11.100	---	---	---	---	---	---
W4	ME04	11/13/93	12:00	.171	13.3	12.0	8.410	2.580	0.120	45	11.910	---	---	---	---	---	---
W4	ME05	11/20/93	15:00	.138	15.6	14.6	8.720	2.410	0.110	13	11.640	---	---	---	---	---	---
W4	ME06	12/19/93	17:00	.277	10.0	12.3	8.300	2.470	0.110	383	10.130	---	---	---	---	---	---
W4	ME07	1/4/94	17:00	.050	11.1	12.7	8.340	2.520	0.120	3	10.300	---	---	---	---	---	---
W4	ME08	1/21/94	17:25	.108	14.4	12.5	8.490	2.520	0.120	1	10.030	---	---	---	---	---	---
W4	ME09	2/2/94	12:45	.184	12.8	10.2	8.450	2.570	0.120	35	12.960	---	---	---	---	---	---

SITE	EVENT	DATE	TIME	Q	AIR TEMP (C)	WATER TEMP (C)	pH	COND	SALINITY	TURB	DO	NITRO	PHOS	SUSPND SOLIDS	DISS SOLIDS	TOTAL COLI	FECAL COLI
W4	ME11	3/7/94	12:40	.662	15.6	18.7	8.390	2.010	0.090	130	10.690	---	---	---	---	---	---
W4	ME12	3/21/94	16:00	.341	14.4	21.0	8.340	2.120	0.100	207	9.040	---	---	---	---	---	---
W4	ME13	3/30/94	14:45	.422	17.2	22.7	8.380	2.090	0.100	188	9.350	---	---	---	---	---	---
W4	ME14	4/17/94	13:00	.399	16.1	21.4	8.300	2.260	0.100	9	9.580	---	---	---	---	---	---
W4	ME15	4/30/94	17:00	.245	11.7	19.6	8.580	2.290	0.110	3	10.350	---	---	---	---	---	---
W4	ME16	5/15/94	10:00	.232	12.8	15.0	8.260	2.320	0.110	73	11.260	---	---	---	---	5000	5000
W4	ME17	5/29/94	15:00	.163	22.2	27.5	8.450	2.370	0.110	9	9.240	---	---	---	---	---	---
W4	ME18	6/12/94	16:40	.193	15.6	19.4	8.350	2.470	0.120	1	10.430	---	---	---	---	---	---
W4	ME19	6/26/94	14:15	.098	25.6	28.9	8.360	2.620	0.120	1	9.940	---	---	---	---	1700	500
W4	ME20	7/24/94	14:15	.137	19.4	25.9	8.430	2.610	0.120	7	9.740	---	---	---	---	---	---
W4	ME21	8/22/94	12:50	.119	19.4	23.3	8.400	2.640	0.130	6	10.930	---	---	---	---	---	---
W4	ME22	9/1/94	13:00	.067	16.1	20.7	8.270	2.610	0.120	6	11.900	---	---	---	---	---	---
W4	ME23	10/17/94	12:10	.052	16.7	13.3	8.320	2.680	0.130	15	14.000	---	---	---	---	---	---
W4	ME24	10/24/94	12:45	.075	18.3	15.7	8.430	2.610	0.120	115	11.470	---	---	---	---	---	---
W4	ME25	10/31/94	11:50	.088	25.0	14.9	8.150	2.580	0.120	5	11.900	---	---	---	---	---	---
W4	ME26	12/3/94	12:20	.105	12.2	12.7	8.270	2.540	0.120	---	11.190	---	---	---	---	---	---